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THESIS

THE IMPACT OF USER-INPUT DEVICES ON VIRTUAL DESKTOP TRAINERS

by

William R. Glaser

September 2010

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13. ABSTRACT (maximum 200 words)

Virtual desktop trainers have become ubiquitous in the U.S. military and have the capability of altering their user interface. The military will gladly pay for additional peripheral devices but only if they can demonstrate improved training effectiveness. This research project seeks to establish an input device configuration solution for virtual desktop trainers. Specifically, we compared the standard laptop keyboard and mouse to a configuration incorporating a game controller. Additionally, we investigated the value of incorporating a head-tracking device. These peripheral devices could minimize the time required to gain sufficient gaming proficiency, resulting in more time dedicated to training military skills. We employed a within subjects experimental design to evaluate young active duty Soldier's ability to move and shoot in a virtual environment using different input devices. We found that the keyboard and mouse was superior to the game controller configuration in overall performance. The one exception was during the driving event. The head tracker was found to be detrimental to overall performance. Our recommended configuration consisted of the keyboard and mouse without the head tracker for standard users and only providing game controllers to Soldiers who drive vehicles

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THE IMPACT OF USER-INPUT DEVICES ON VIRTUAL DESKTOP TRAINERS

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ABSTRACT

Virtual desktop trainers have become ubiquitous in the U.S. military and have the capability of altering their user interface. The military will gladly pay for additional peripheral devices but only if they can demonstrate improved training effectiveness. This research project seeks to establish an input device configuration solution for virtual desktop trainers. Specifically, we compared the standard laptop keyboard and mouse to a configuration incorporating a game controller. Additionally, we investigated the value of incorporating a head-tracking device. These peripheral devices could minimize the time required to gain sufficient gaming proficiency, resulting in more time dedicated to training military skills. We employed a within subjects experimental design to evaluate young active duty Soldier's ability to move and shoot in a virtual environment using different input devices. We found that the keyboard and mouse was superior to the game controller configuration in overall performance. The one exception was during the driving event. The head tracker was found to be detrimental to overall performance. Our recommended configuration consisted of the keyboard and mouse without the head tracker for standard users and only providing game controllers to Soldiers who drive vehicles.

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LIST OF ACRONYMS AND ABBREVIATIONS

6DOF	Six Degrees of Freedom
AAR	After Action Review
AO	Area of Operations
ANOVA	Analysis of Variance
ASVAB	Armed Services Vocational Attitude Battery
BCTC	Battle Command Training Center
CAS	Close Air Support
COTS	Commercial Off-the-Shelf
DARPA	Defense Advanced Research Projects Agency
DIS	Distributed Interactive Simulation
D-Pad	Digital Pad
DMSO	Defense Modeling and Simulation Office
DoD	Department of Defense
DVTE	Deployable Virtual Training Environment
FORSCOM	Forces Command
HASP	Hardware-Assisted Software Protection
HT	Head Tracker
HLA	High Level Architecture
HMMWV	Highly Mobile Multi-Wheeled Vehicle
ICT	Institute for Creative Technologies
ID	Identification
IED	Improvised Explosive Device
IR	Infrared
IRB	Institutional Review Board
I/ITSEC	Interservice/Industry Training, Simulation, and Education Conference
JAR	Java Archive
JCATS	Joint Conflict and Tactical Simulation

JSAF	Joint Semi-Automated Forces
JSIMS	Joint Simulation System
KB	Keyboard
ModSAF	Modular Semi-Automated Forces
MOVES	Modeling, Virtual Environments, and Simulation
USMC	United States Marine Corps
MULE	Multifunction Utility/Logistics and Equipment
NCO	Noncommissioned Officer
NPS	Naval Postgraduate School
OneSAF	One Semi-Automated Forces
ONR	Office of Naval Research
OIF	Operation Iraqi Freedom
OPORD	Operational Order
PC	Personal Computer
PII	Personally Identifiable Information
PS	PlayStation
PS2	PlayStation 2
PS3	PlayStation 3
PEO-STRI	Program Executive Office Simulation, Training, and Instrumentation Command
PDU	Protocol Data Units
SISO	Simulation Interoperability Standards Organization
SNES	Super Nintendo Entertainment System
SD	Standard Deviation
ST	Skilled Technical
TRADOC	Training and Doctrine Command
TTP	Tactic, Technique, Procedure
UAV	Unmanned Arial Vehicle
UDP	User Datagram Protocol
U.S.	United States

USB	Universal Serial Bus
VBS	Virtual Battlespace
VBS2	Virtual Battlespace 2
VCCT	Virtual Combat Convoy Trainer

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I.   INTRODUCTION

A.   PROBLEM STATEMENT

Personal computer and console gaming technology has advanced to the point where virtual desktop trainers have become ubiquitous to the U.S. military. Numerous training transfer studies have been conducted demonstrating that personal computer and console gaming technologies are at least as effective as traditional training methods (Brown, 2010).   Virtual desktop trainers have the capability of altering the interface by adding game controllers, larger screens, head mounted displays, head-tracking devices, and improved communication interfaces.   Recent virtual desktop training transfer studies have recommended investigating the effectiveness of these peripheral devices to determine whether they add enough training benefit to justify their cost and added logistical burden. The military will gladly pay for additional peripheral devices but only if they can demonstrate an improvement on training effectiveness.

This thesis seeks to recommend a configuration solution and provide Commanders and Battle Command Training Center (BCTC) directors a reference when making their virtual desktop trainer peripheral interface decisions. Specifically, we compared the standard laptop keyboard and mouse as user-input device to a configuration incorporating a game controller.   Additionally, we compared the standard laptop configuration to a configuration incorporating a head-tracking device.

We defined the problem as: "When using a virtual desktop simulation for training, do commercial head-tracking and video game controller devices improve training effectiveness by providing a more intuitive user interface?"

A more intuitive user interface could minimize the initial training time required to teach users to perform basic individual, weapon, and vehicle functions in a virtual desktop simulator.   This time savings would result in more time available to train the skills that will keep a soldier alive in combat.

This thesis project aims to gain insight into where the trainer should invest his money. The military willingly spends money to offer the best possible training to Soldiers and Marines, but the extra expense must have proven worth. One such expense is peripheral devices used in conjunction with Virtual Battlespace 2 (VBS2^{TM}). Peripheral devices considered in this study have the potential to leverage recent advances in gaming technology and trainee gaming experience. These peripheral devices could improve individual gaming performance and minimize the time required to gain sufficient gaming proficiency. This would result in more time dedicated to training military skills using the game as a tool instead of learning how to play the game. The research team proposes to gain insight into user-input interfaces by investigating both performance effects and subjective preference.

B.   RESEARCH QUESTIONS

1.   Do user-input devices impact military training performance when used with a desktop virtual training simulation?

2.   Do soldiers prefer one user-input device over another when using a desktop virtual training simulation?

C.   HYPOTHESES

1.   The addition of a commercial head-tracking device to virtual desktop simulations will improve performance in a virtual training simulation and be preferred over no head-tracking device.

2.   The addition of a commercial game controller device to virtual desktop simulations will improve performance in a virtual training simulation and be preferred over the standard keyboard and mouse.

D.   EXPLORATORY HYPOTHESES

Do factors, such as age and map representation influence the effect of user input device on performance and preference?

E.   MOTIVATION

The U.S. Army and Marines are currently fielding VBS2^{TM} to Forces Command (FORSCOM) units, Training and Doctrine (TRADOC) school houses, and Battle Command Training Centers (BCTC).   The current VBS2^{TM} configuration utilizes a standard keyboard with no game controller or head-tracking options. The U.S. Marine Corps currently deploys VBS2^{TM} as part of the Deployable Virtual Training Environment (DVTE).   DVTE is a laptop-based platform for a wide variety of training simulations in the United States Marine Corps (USMC).   The U.S. Army typically installs VBS2^{TM} on standard desktop personnel computers (PC).   In summary, both services are fielding the system using a keyboard as the user-input interface with no game controller or head-tracking options.

In order for the simulation to be useful, Soldiers and Marines must use the interface to proficiently drive vehicles, shoot weapons, and maneuver their bodies as they would in the real world. This study sought to determine whether the game's keyboard and mouse interface was comparable to using a PlayStation 3 game controller.

VBS2^{TM} has the capability to change the user-input interface from keyboard to the Sony Playstation 3 (PS3^{TM}) game controller and to integrate with NaturalPoint's TrackIR 5 head-tracking technology. The PS3^{TM} game controller is ergonomically engineered to be a more intuitive device to control a playable character or vehicle in a video game.   NaturalPoint's TrackIR 5 head-tracking technology allows the user to change the player's view perspective in the virtual environment by simply moving their head.

Unit Commanders and BCTC Directors need to decide how to configure VBS2^{TM} user-input interfaces, in order to maximize the VBS2^{TM} training experience.   This research project seeks to recommend an optimum configuration that minimizes the training time required to teach users to perform basic individual, weapon, and vehicle function in VBS2^{TM}. By reducing this initial

training time, we will maximize the amount of time a Soldier or Marine can spend focusing on military training instead of learning a game.

F. SOLDIER, SAILORS, MARINES, AIRMEN, AND COAST GUARDSMEN

This thesis research project was originally conceived by a United States Marine Corps Officer but planned and executed by a United States Army Officer. The study participants were officers and enlisted service members attending the Defense Language Institute or the Naval Postgraduate School representing every U.S. Armed Service. There were even international service members represented as well.

This was truly a joint operation with all military services well represented. From this point on, we will simply use the term "Soldier" when referring to all service members, all of which have given some, and some will be asked to give all.

G. SCOPE OF THE THESIS

The primary purpose of this thesis is to determine the correct combination of peripherals to maximize the VBS2™ training experience. This thesis will focus on user-input devices. Specifically, it will focus on how different combinations of user input devices affect individual mounted and dismounted movement within the VBS2™ virtual training environment, ability to accurately identify and engage targets with personal and crew served weapons. The scope of this thesis will not include the value of specific peripherals in training collective task (team) training.

H. BENEFITS OF STUDY

This thesis seeks to establish a recommended user input device configuration for virtual desktop trainers such as VBS2™. It will also serve as a reference to BCTC directors when making their VBS2™ peripheral interface decisions. This guidance will be supported with research data that will demonstrate cause and effect outcome of said use. A main benefit of this study is the potential time saving in training and subsequent increase in important

military training. It also has the potential to address who and under what conditions will most benefit from the recommended configuration.

I.   THESIS ORGANIZATION

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II. BACKGROUND

A. INTRODUCTION

Today, the U.S. military operates in an environment that is characterized by uncertainty, complexity, and rapid change. To prevail in this environment, the United States Armed Forces must be capable, against a plethora of current threats, adaptable to rapidly emerging new threats, and ready to respond across the full range of military operations. The non-state, insurgent and terrorist adversaries the nation currently faces around the world have chosen asymmetric approaches to warfare that avoid the conventional strengths of the United States Armed Forces. To counter these threats, the military must remain creative and flexible if we are to confound our enemies' designs.

Training with virtual simulations offers great potential to keep the military units at its maximum effectiveness by instilling adaptability and flexibility before the force is engaged in combat. By exposing leaders at every level to the complex operational environment, training with virtual simulations offers an efficient and effective way to increase the readiness of the United States Armed Forces from the headquarters to the small unit and individual level.

Across all warfighting communities, simulated training advances have been significant, yet the use of advanced simulation technology has not been achieved for the training of infantry small units in close combat. State-of-the-art simulation training that is demanded and accepted as routine for aviation, armor, or maritime forces, is negligible or almost non-existent on a large scale for U.S. ground forces.

Since 1945, American infantry units have suffered over 80 percent of our nation's military casualties. Research concludes these casualties often occur in the initial fire fights, yet very few resources have been applied to the development of realistic immersive simulation of ground operations to prepare ground troops for their first engagements with the enemy. Though the

rudimentary simulation designed for close combat currently affords units some level of challenge, it does not yet approach the level of sophistication that is commonplace and deemed essential in the other warfighting disciplines.

B.   VIDEO GAMES AND THE U.S. ARMY

In 1980, a group of retired general grade officers approached Atari^{TM} with the idea that the technology form the Atari game Battlezone could be used to train soldiers for the then new Infantry Fighting Vehicle. Over the next year, Atari transformed Battlezone into a military training device. At the 1981 Worldwide Training and Doctrine (TRADOC) Conference, the new training simulator was unveiled. The U.S. Army was beginning to recognize that future Soldiers would grow up in an environment of electronic gadgetry, and teaching methods for this new breed had to be developed accordingly.

During the 1981 Worldwide TRADOC Conference, General Donn Starry asked the question "In an era that has seen such fantastic technological achievements, how is it that our Soldiers are still sitting in classrooms, still listening to lectures, still depending on books and other paper reading materials, when possibly new and better means for training have been available for many years?" (Halter, 2006). General Starry asked a question that is still pertinent more than a quarter century later.

The first three decades of modern computer history produced machines so expensive and cumbersome that they remained the domain of large funding efforts, such as Defense Department projects. Through the Cold War, simulation enabled blue icons and red icons to march across screens toward each other while numerous mathematical calculations cranked out answers to who won and lost each engagement. Post Cold War strategy and tactics changes suggested the need for new types of simulation. The military looked around and saw a civilian gaming market flooded with new and interesting technology.

After the initial 2003 invasion into Iraq, the U.S. Army found their biggest weakness was their ability to safely conduct logistical convoys. The U.S. Army

did not have a convoy trainer so they asked the Defense Advanced Research Project Agency (DARPA) for assistance. In 2004, DARPA went to the civilian gaming market for an answer, where they found Operation Flashpoint. DARPA initiated a variety of changes to make the game military and realistic and produced DARWARS Ambush! (Peck, 2004). Soon the Army used the simulation both in theater and stateside to enhance training. Additionally, personnel began to experiment using the game for rehearsal with Soldiers at Fort Polk providing virtual tours of the places where troops would fight weeks later (Laurent, 2007).

In August 2008, Smith responded to an interview question about modern Soldiers' familiarity with computer games "Our research and hands-on experience shows that about 50 percent of young enlisted Soldiers call themselves "gamers" or are familiar with the mechanics of game play. At the officer level, it is around 33 percent. We have learned that we cannot assume that all Soldiers have this familiarity" (Atkinson-Bonasio, 2008). While the wired generation may know cell phones and iPods, they do not necessarily know how to use the games that support military training. Moreover, military training cannot leave the 50 percent or any other percentage of non-gamers behind.

On 5 January 2009, the U.S. Army announced Bohemia Interactive was the prime contractor for a new training program known as "Game After Ambush". The Program Executive Office for Simulation, Training, and Instrumentation (PEOSTRI) awarded the contract to provide an enterprise level license for a desktop training simulator to the U.S. Army. It also stated that Bohemia Interactive's "Virtual Battle Space 2" (VBS2 ^{TM}) is the base platform to satisfy the U.S. Army's desktop virtual training environment needs. VBS2^{TM} has already been adopted by the U.S. Marine Corps, and the Armed Forces of the United Kingdom, Australia, and New Zealand. Today, there are over 10,000 U.S. Army personal computers with VBS2^{TM} installed for training purposes.

C.   VIRTUAL DESKTOP TRAINERS

As the civilian computer gaming market has matured its product line, military, medical, educational, and other communities have considered the training value of this software. The military uses civilian games for training and analysis. To distinguish computer gaming with an actual military purpose from typical civilian games, Ben Sawyer, a high-tech freelance writer and technology consultant coined the term "virtual desktop trainers," and the term has caught on (Macedonia, 2005). Two Canadian researchers summarized potential uses for Virtual desktop trainers in a paper prepared for the 2008 Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC). These uses include showing viewpoints of opposing forces, teaching action drills, improving post-exercise analysis with different perspectives, and representing future technologies not yet available for conventional training (Roman & Brown, 2008).

Virtual desktop trainers face a potential drawback because of their interfaces. Game manufacturers expend much effort producing the most intuitive, efficient, and user-friendly interface for their software, but for any game, users must learn the interface. When training with virtual desktop trainers, military personnel must move, shoot, and communicate with the same ease as they do in live training events. The game interface must serve as an extension of the service member's warfighting skills. Interface training clouds the potential gain of virtual desktop trainers' ability to train because of the extra time required and the artificiality and the non-veridicality of the interface. If the individual did not have to learn the game, he or she could do something more productive. The military does not need games for gaming sake; gaming only serves as a means to an end. With this in mind, military virtual desktop trainers endeavors should strive to minimize time lost to learning the interface.

D.   THE INTERFACE ISSUE

The game interface issue has bubbled under the surface of the civilian gaming community for years. Civilian gaming does not have performance goals

per se; rather, goals orient around entertainment and money. In many ways, the civilian game interface issue gets to the crux of the choice between console and personal computer based games. Most American households sport at least one personal computer, so the game console is an extra machine in the household. Gamers need an incentive to buy that extra equipment, so the high dollar console gaming industry has a direct interest in keeping players on game controllers. This interest goes so far as to design the game to optimize the effects of the controller. Little research has been done on which interface is better, but the Internet is full of user opinion on the subject. For example, blogger D. Coldewey (2009) wrote a recent discourse on the virtues of a personal computer interface in first person shooters, summing up by stating that the interface performance is platform dependent, and thus a platform issue despite his keyboard interface preference.

These civilian game interface design ideas typically orient on entertainment value. The military, on the other hand, value realism over entertainment. Transparent extension of warfighting skills is the key determinant of game value. In this respect, performance in the long run is not as much a consideration as the ease with which the average Soldier can learn the interface and get down to effective training. The interface must be as intuitive to a novice as it is effective in facilitating training effect in the game.

E. EVOLUTION OF GAME CONTROLLERS

A controller is a device used with games or entertainment system to control a playable character, vehicle, object, or otherwise influence the events in a computer or video game. It is the way a player communicates with the game. Some examples of controllers are keyboards, mice, game controllers, joysticks, steering wheels for driving games, and light guns for shooting games. The type of controller used depends on the genre of the game being played.

A game controller is a special type of controller held in the hand, where the digits (especially thumbs) are used to provide input. Game controllers generally feature a set of action buttons handled with the right thumb and a direction controller handled with the left. Modern game controllers can all trace their layout and functionality to the Super Nintendo Entertainment System (SNES) game controller, which in the early 1990s popularized the layout used by most modern game controllers.

Figure 1.   Super Nintendo Entertainment System (SNES) game pad (From Mitchell, 2010)

Some common additions to the standard game controllers include shoulder buttons placed along the edges of the pad, centrally placed start, select, and mode buttons, and an internal motor to provide force feedback.

Over the past forty years, video game controllers have gone through many changes that have made controlling a character easier and playing the game more enjoyable. Some of these changes include the design of controllers, the controller interface, and ergonomic changes made to controllers.

In the early 1970s, when the first Atari^{TM} units came out, the controller was actually built into the console. This design meant that players had to sit by the console to play. Aside from being annoying, it also presented another problem. If a controller was to break, or malfunction, then the entire system had to be brought in for repair. The Atari 2600^{TM} was one of the first systems that allowed

you to disconnect the controller from the console. This feature allowed players more freedom while playing the game and made it easier to fix controllers. As the video game controller continued to evolve, new innovations were introduced, such as longer connector cables, cable extensions, and wireless controllers (Watcher, 2010).
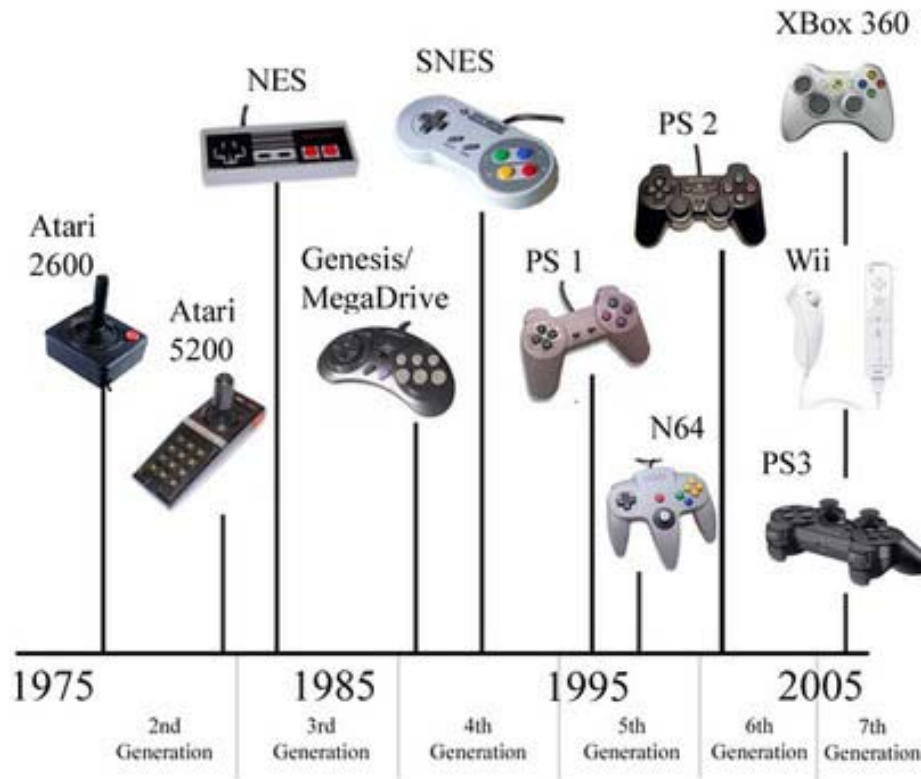
Figure 2.   Evolution of Console Game Controllers Over Time (From Lopez, 2010)

Video game controllers went through a vast change in the way players communicated with the console. In the beginning, controllers used knobs in order to move the character up or down, and eventually left or right. Knobs were later replaced by the invention of the joystick. The joystick allowed players to move a character in multiple directions simply by moving the joystick. A single action button also accompanied joysticks. This single action button later turned into multiple buttons. The downsides to the joystick were minor strain on the wrist and they were easily broken due to excessive force from the player. During

the 80s and 90s the invention of the digital pad (D-Pad) changed controller interface for the better. It allowed players to have the same motion as the joystick, without the hassles the joystick presented. The D-Pad also allowed for the easy use of multiple buttons, and the functions of slow motion and rapid-fire simulation. In the mid to late 90s, two controllers came out that revolutionized gaming. These two game controllers were the Playstation and Nintendo-64 game controllers.

The original Sony PlayStation was released in 1995 and its game controller had a cross-shaped button layout and also had four shoulder buttons. This total of 8 action buttons allowed players control in unprecedented ways. Also, along with a D-Pad, two analog sticks move a character like never before. These sticks allowed a player to control the speed of a character by controlling the amount of pressure applied to the stick (Watcher, 2010).

Figure 3.   Original Playstation Game Controller (From Mitchell, 2010)

The Nintendo-64 was released in 1996, and its game controller featured many of the same innovations with a somewhat different layout. Instead of two analog sticks, the Nintendo-64 controller only had one analog stick. Also, the controller featured six face buttons with two shoulder buttons. These two controllers lead to the modern controllers that we have today (Watcher, 2010).

Figure 4.   Nintendo-64 Game Controller (From Mitchell, 2010)

Most of today's modern controllers provide the same features as the original PlayStation game controller.   Face buttons and shoulder buttons are used for character's actions and two analog sticks and a D-Pad is used for a character's movements.   However, today's modern day controllers feature some ergonomic changes that make playing video games much easier and more enjoyable.   While the Sony PlayStation 3 game controller is almost identical to its predecessor, the Xbox 360 game controller features a design that fits the players hands.   Both of these controllers use recent technology such as Wi-Fi and Bluetooth that allow for wireless gaming and a long lasting battery life (Watcher, 2010).

Figure 5.   Sony DualShock PS3^{TM} and Microsoft Xbox 360^{TM} Game
Controllers (From IGN, 2010)

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Video game controllers have expanded into using infrared (IR) technology to track player's head movements. These head movement are then translated into the game by changing the players' visual perspectives. Over the years, video game controllers have evolved from primitive knobs to advanced controllers using a variety of buttons, sticks, and body tracking for better gaming experience.

F. USE OF GAME CONTROLLERS OUTSIDE OF VIDEO GAMES

1. Introduction

The evolution and improvements of game controllers have resulted in other industries leveraging the advantages of game controllers to manipulate more than just games. The examples are numerous but I will focus on how the military is leveraging the experience of soldier's playing video games to better equipment them in performing their war-time duties. The following are just a few examples of where game controllers are finding homes outside of video games.

2. Office of Naval Research

In May 2008, the Office of Naval Research (ONR) hosted "Fleet Week" in New York. This "Fleet Week" allowed some of the writers from Popular Mechanics magazine to check out some of the new weapons the Office of Naval Research was developing. One of the new weapons system on display was the new Lightweight Stabilized M240 Weapon System. This system is a swiveling rooftop gun mount for Highly Mobile Multi-Wheeled Vehicle (HMMWV) and is completely controlled from inside the vehicle. One Popular Mechanics writer commented on how similar the sighting system was to a video game. The ONR representative agreed and then proceeded to demonstrate an alternate weapons control system that utilized a XBOX 360 game controller to manipulate and sight the Light Weight Stabilized M240 Weapon System. This system has been fielded and deployed to service members serving in Iraq and Afghanistan (Derene, 2008).

3. Improvised Explosive Devices (IED) Disposal Robots and Unmanned Ground Vehicle Robots

The fight to counter the deadly IED in Iraq and Afghanistan has had few highs and too many lows. One of the bright spots is the development and fielding of IED disposal robots such as the Talon, manufactured by Foster-Miller, and iRobot's Packbot. They have both proved their worth, and saved lives by lessening the exposure of Explosive Ordinance Disposal personnel to bombs. Byron Brezina, robotics director of Naval explosive ordnance technology division, thinks that this technology is great "but we can do better" (Magnuson, 2008).

One of the recent improvements is the addition of game controllers that closely resemble the Sony PlayStation game controller. One of the driving factors in choosing the game controller was that "it is an intuitive system for those who grew up playing video game" according to Kevin Harrington, an account manager at iRobot (Magnuson, 2008). According to Harrington, it takes less than 10 minutes to learn to drive the robot regardless of any video game experience. "All you need is two thumbs and a couple fingers for this" (Magnuson, 2008). Both the Talons and the Packbots have fielded the new PlayStation-like controller as part of the user-input device. The commander of Task Force Troy, the U.S. military's in-country counter-IED team, said the game controllers were well received by the IED disposal robot operators. "Soldiers play a lot of games when they're not working. It was very intuitive for them."

Defense Advanced Research Projects Agency (DARPA) also has seen the potential of game controllers outside of video games. As part of the U.S. Army's and DARPA's Unmanned Ground Vehicle program, Lockheed Martin developed the Multifunction Utility/Logistics and Equipment (MULE) system to transport equipment over complex terrain and obstacles that a dismounted squad will encounter during combat operations. When reporters from *Popular Mechanics* visited the developers of the MULE at a test track in Grand Prairie, Texas, they saw the MULE operator using a XBOX 360 game controller to drive

the vehicle. The system is still in the development phase but engineers predict some variation of game controllers will be used as the primary user-input device (Sofge, 2009).

4.   Raytheon System Development

Mark Bigham, director of business development for Raytheon Tactical Intelligence Systems, had this to say about game controller expanding out of the video game community, "There are a lot of important lessons to learn from the gaming community" (Derene 2008). Bigham then explains how in the past, the military far outspent the gaming industry on human-interface technology, but now that has changed. The gaming industry is a huge market that enables game developers to investment huge sums of money on research and development. According to Bigham, game developers have dwarfed what the Department of Defense would spend developing these type of controllers.   Instead of reinventing the wheel, the Department of Defense is adopting this off the shelf technology that millions of youths are using on a daily basis.

Figure 6.   U.S. Army Soldier using a XBOX Controller (From Derene, 2008)

Raytheon is now developing unmanned aerial vehicles and improvised explosive devices disposal robots that utilize game controllers. They believe the use of game controllers has the potential to greatly decrease the number of accidents that occur. Raytheon states that using off the shelf game controller technology could save the military $500 million in about ten years. In addition to advances made for UAVs, there have been significant advances in the use of ground robots as well. *New Scientist* magazine reported on how the remote is being used to replace traditional joystick controls for IED disposal robots. David Bruemmer, an engineer at the U.S. Department of Energy's Idaho National Lab, says, "The problem with the original joypad designed for the IED disposal robot is that it takes a lot of concentration of the soldier using it," Bruemmer also goes on to say that the game controllers are more intuitive because hand movements transfer directly into movements of the robot. This feature should allow a more instinctive approach to controlling the robot (Hambling, 2008).

While some say that those spending time playing games such as Halo 3 and Modern Warfare are wasting time, others believe that they are undergoing a form of training that does not cost anything. When training to fly F-16s, soldiers in their early 20s preferred a game controller to the throttle and stick controls. In addition to integrating XBOX game controllers into their combat systems, Raytheon has also been experimenting with using the Wii controller for training that requires physical movement (Derene, 2008).

G. PERSONAL COMPUTER VIDEO GAMES VERSUS CONSOLE VIDEO GAMES

1. Background

In the modern world of gaming today, there is an ongoing debate regarding which is better, a PC or a video game console. In the beginning, there was no denying the advantage of the PC. As video games originated on PCs, consoles were viewed as primitive and lacking. As the console progressed, it began to have more and more of the same features as the PC. As time continues forward, the debate between PCs and consoles grows larger. There are many topics that fuel this debate including graphics, gaming experience, social aspects, and the cost of both hardware and software.

The ease and enjoyment of the gaming or training experience is also important. This is a hotly debated question between gamers. The console gaming side believes their controller interface, reliability, and constancy of performance tips the scales in their favor. They argue that the game software is designed to a closed system that maximizes the gaming experience. Whereas, PC games must perform on PCs using different technical configurations. Console video games' single configuration results in much higher reliability compared to the vagaries of PC gaming systems. This makes it hard for software developers to pinpoint the problem and fix the glitch. However, PCs have an advantage in

the content of games. While consoles still have a decent selection, they have nowhere near the amount of games PCs do. Also, consoles cannot even play all of the games from their predecessors.

While PCs have ruled multiplayer (two or more players playing simultaneously) for a long time, they are now falling to consoles. Although both PCs and consoles allow you to play online with a number of others, consoles have a more efficient method of communication. Consoles have built in voice chat, whereas PCs have poorly designed video chat built into the game, or the need to open a third party program.

The last issue is cost. Considering everything needed, a mid range PC and console video gaming system are about the same price. However, as technology progresses and new games come out, the PC will become outdated faster than the console. Recently, console video game companies readily admitted that they lose money when selling the baseline console video games system. These systems are so cutting edge at their release date, that the research, development, and manufacturing cost far outweigh the initial purchasing price. The gaming companies then explain it's the profits from video game software that creates a significant downstream revenue. At the moment, PCs and consoles have many of the same features, and thus whether PC or console is more enjoyable is simply a matter of preference.

2.   Studies Comparing PC and Console Video Games

There have been very few studies comparing PC based video games and console based video games for military training purposes. A team of Swedish scientists from Linkoping University and Jonkoping University did conduct a study in 2009 focusing on visual search strategies using both PC and console video game platforms. The aim of the study was to compare military trained personnel with non-military trained personnel with respect to visual fixation techniques to identify object of interest and areas of interest. One of the controls was varying the game platform from PC and Console.

The video game chosen was the First to Fight™ game (Destineer Studios). The XBOX was chosen as the console video game platform. The researchers found very little difference in performance between the PC video game configuration versus the console video game configuration. At the end, they did state it seemed that there was a non-significant trend toward the PC outperforming the console video game configuration (Falkmer, 2010).

H. VIRTUAL BATTLESPACE 2™ (VBS2™)

Bohemia Interactive Virtual Battlespace 2™ (VBS2™) is the successor of the Virtual Battlefield Simulation (VBS™). It was developed in close cooperation with the United States Marine Corps (USMC), Australian Defence Force and other military customers of the original VBS™. VBS2™ was officially launched on 17 April 2007 and purchased by the U.S. Army in February 2009.

VBS2™ is a fully interactive, three-dimensional training system providing a synthetic environment suitable for a wide range of military training and experimentation purposes. It offers battlefield simulations and the ability to operate land, sea, and air vehicles. Instructors may create new scenarios and then engage the simulation from multiple viewpoints. VBS2™ is used to teach tactics, techniques, and procedures at the lower tactical level in multiple types of operations (VBS2™ Manual, 2009).

It provides a high-fidelity virtual environment, suitable for squads and platoons to train mission rehearsals, area of operations (AO) familiarization, convoy operations, react contact drills (improvised explosive devices (IED), snipers, ambushes and other insurgent tactics), troop leading procedures and tactical decision making.

VBS2™ is a fully-featured training tool including after-action review capability, high level architecture (HLA) / distributed interactive simulation (DIS) compliance, and a comprehensive yet easy-to-use mission editor that allows any

imaginable scenario to be created and also modified in real time. Mission design simplicity is improved with a new "point and click" interface, which replaces the time consuming text driven editor.

Capabilities include, but are not limited to, multiple weapon platforms and vehicles, integrated close air support (CAS) & fire support simulation. It also provides the ability to customize terrain and build scenarios to meet unit training needs. For example, day, night or limited visibility situations are available to integrate night vision and thermal site capability into customized scenarios. The ability to customize training scenarios is currently unmatched by anything the U.S. Army has in its training simulations arsenal. This capability is provided to VBS2^{TM} through the use of the commercial gaming engine Real Virtuality 2 created by Bohemia Interactive (VBS2^{TM} Manual, 2009).

VBS2^{TM} has enjoyed some scientific scrutiny, and this prior research has shed some light on the time required to learn and use the simulation as an extension of one's warfighting skills. In 2004, an Australian research team conducted a weeklong trial to determine the potential utility of the VBS2^{TM} predecessor, VBS2^{TM}. The trials involved a group of participants varying in computer and gaming experience with roughly half the people having no gaming experience. The study determined that nearly 80 percent of new users can attain individual skill proficiency within a couple hours. For higher level cognitive skills, such as situational awareness and team leadership, participants needed up to two, eight hour days to become proficient in the game play (Morrison, Barlow, Bethel, & Clothier, 2005).

There are several gaps in understanding how to most effectively use VBS2^{TM} as a training device for Soldiers. This thesis attempts to address some of these gaps. Specifically, we investigate the impact of using a Sony PS3^{TM} Game Controller to replace the standard keyboard and mouse as an user-input device. It also address the question, does the addition of Naturalpoint's TrackIR 5^{TM} improve the performance of the participant?

I.   PLAYSTATION 3 GAME CONTROLLER

1.   PlayStation (PS) Game Controller

Sony's original PlayStation (PS) game controller was introduced in 1995 and featured a four direction D-pad, four action buttons (referred not by color or letter/number like most pads back then, but by four colored shapes - △, ○, ✕, ☐), four shoulder buttons (R1, R2, L1, and L2, standing for *right* and *left*) and start and select buttons. The basic design and layout were based on that of Nintendo's Super Nintendo Entertainment System (SNES) controller, as the PlayStation was originally developed for the SNES, before becoming a console in its own right.

2.   PlayStation 2 (PS2) Game Controller

In 2000, Sony released PS2 with the introduction of Sony's PS2 DualShock game controller. This device could vibrate to provide the player with tactile feedback, cosmetically changed the handles, analog sticks and "L2 and R2" buttons, and added "L3 and R3" buttons, which were incorporated into the sticks themselves (accessed by pushing down on the stick). Its popularity resulted in the DualShock becoming the de facto standard that all other console game controller were compared. Other minor modifications made include the change of cable and end connector color from grey to black, a slight squaring of the connector and "DUALSHOCK 2" printed in blue on the top of the controller next to where the cable enters.

3.   PlayStation 3 (PS3^{TM}) Game Controller

Initially, the conceptual controller for the PlayStation 3 was similar to its Dual Shock; however, it was much more curved in shape than these controllers, with an appearance similar to that of a banana or boomerang. This odd shape has often been the subject of much ridicule and was abandoned in 2006.

The PlayStation 3's Dual Shock 3 wireless controller includes both vibration function and the motion-sensing functionality. The DualShock 3 is cosmetically similar to the DualShock 2, but has several new features that distinguish it. It is a wireless controller and features the addition of tilt-sensor and linear accelerometer technology, as well as larger 'trigger-like' L2 and R2 buttons. It is charged by way of a mini-USB port situated where the cable on its predecessors left the controller, which can also be used to allow wired play. However, the new controller lacks the rumble capability featured in the preceding DualShock 2 controllers due to patent infringement legal issues with the haptic-feedback technology (see Figure 5).

Having settled the legal issue in late 2007, Sony relaunched the DualShock 3. The controller is the same as the previous DualShock 3 in almost every way but differs in that the blue lettering next to the USB port has been changed to DualShock 3, it contains the aforementioned vibration motors, which also give the controller more weight. This study will use the Sony PlayStation 3 game controller as the alternative user-input device.

J.   NATURALPOINT TRACKIR 5 ™

1.   Introduction

TrackIR 5™ is an optical motion tracking game controller for Microsoft Windows, created by Naturalpoint Inc. that tracks head motions with up to six degrees of freedom (6DOF), allowing hands free view control for improved game immersiveness and situational awareness. Head position and orientation are measured by a purpose-built video camera, mounted on top of the user's monitor, which observes invisible infrared (IR) light (hence the name) reflected or emitted by markers on a rigid model worn by the user. TrackIR ™ software is used to access and control the camera, as well as adjust tracking and manage game profiles. The ratio of actual head movement to virtual head movement can be changed, allowing the virtual head to turn 180 degrees whilst the user only turns his head a little bit and still looks at the monitor (NaturalPoint, 2010).

The actual kit consists of two main pieces; a universal serial bus (USB) infrared (IR) camera that sits on top of your main monitor, where it's held by a simple adjustable mount. The second is the TrackClip^{TM}, a passive clip with three reflective areas that hooks onto the brim of a baseball cap. The physical set up is simple and installing the software is equally easy.

Figure 7.   TrackIR 5 Infrared Camera (left) and TrackClip (right) (From NaturalPoint, 2010)

2.   Technical Details

TrackIR 5^{TM} cameras have a monochrome sensor with an on-board programmable logic device that pre-processes grayscale video into a threshold binary video. This video is sent to the computer via USB and further processed by TrackIR software to locate markers and from this, estimate head position and orientation, all using only a small amount of bandwidth and CPU (NaturalPoint, 2010).

Now in its fifth iteration, TrackIR ^{TM} is a system designed to turn real head movements into virtual head movements. It works with a number of games that provide a virtual cockpit view, and it effectively uses your head as a kind of mouse-look. Turn your head left, and your view in-game rotates left. Turn right, and your view rotates right. Tilts of the head up and down work along similar lines. However, TrackIR 5^{TM} goes further. In games with full support for all six degrees of movement, you can raise your head up and lower it down, lean left and right or move backwards and forwards, and your view adjusts accordingly.

And as the system exaggerates small head movements into big ones in-game, you never have to turn so far that you can't see the screen. It might not be quite as convincing as being surrounded by a bank of monitors in a serious, commercial simulation, but it should be more immersive than a single static video monitor.

TrackIR 5^{TM} has promoted and established head-tracking in PC games, achieving support from many developers, particularly those involved in the simulation genre. In the process, its interface has become the de facto standard for head-tracking game view control, although other commercial and non-commercial solutions exist (Wallis, 2006). This study will use the NaturalPoint TrackIR 5^{TM} as an additional user-input device.

Figure 8.   Participants using the NaturalPoint TrackIR 5^{TM}

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III. EXPERIMENT AND SCENARIO DEVELOPMENT METHODOLOGY

A. INTRODUCTION

In order to determine the correct configuration of VBS2^{TM} peripheral interfaces, we must define the problem and the game skills required to conduct military training using VBS2 ^{TM}. Once the problem and required skills are defined, the scenario can then be created. Then we will determine how to measure participants' performance. We defined the problem as, which VBS2^{TM} interface configuration provided the most intuitive setup resulting in minimum initial training time and maximum time spent focused on military training instead of learning a game.

The experiment and scenario development was broken down into three phases. The three phases were as follows:

Phase I: Define the scenario and how to measure performance

Phase II: Design and develop the scenario in VBS2^{TM}

Phase III: Design data collection systems

The scenario and data design and development was co-conducted with Major Benjamin Brown of the United States Marine Corps. Major Brown was MOVES student attending NPS during this critical phase. Major Brown and I were classmate in three courses and teamed together to complete course requirements that directly related to the development of my thesis experiment, specifically, scenario development and data collection systems. In this chapter, the term 'we' refers to Dr. Bill Becker, Dr. Quinn Kennedy, Major Ben Brown, and me.

B. PHASE I: DEFINE THE SCENARIO AND HOW TO MEASURE PERFORMANCE

1. What Skills are Required for Conducting Military Training Using Video Games

The first step in defining the scenario is to determine the most important basic gaming skills a soldiers must possess in order to use VBS2^{TM} as an effective virtual desktop trainer. These are the skills that a soldier must already possess or can quickly learn during a familiarization exercise.

Each skill chosen would have to meet three criteria. First, the skill must be required to effectively participate in a virtual military training event. Second, it must be measurable. Third, the participant's ability to execute the skill should reflect the participants' natural ability, gaming experience, and interface configuration.

Shoot, move, and communicate. These three words encompass a Soldier's most basic training directive. If Soldiers can effectively do all three of these things, they will be successful in any tactical mission they encounter. Knowing how to shoot, move and communicate is so vital to the success of a mission, tactical training often focuses on these basics skills. "These are the fundamental basics that will get the Soldiers to more complex maneuvers" (Deweese, 2010).

The two skills we decided to focus on were shooting and moving. In the early stages of this project, we decided to focus on the individual, and exclude any collective training tasks. By focusing on individual tasks, we eliminated the variability introduced when communicating in a virtual environment. Furthermore, the two user-input devices we examine in this project have no impact on Soldier communication skills. We agreed to exclude communication because it was outside the scope of our project. As a side note, during our background research, we discovered that some gamers used the head-tracking device to nod their head. This head nod was used to signal an affirmative or negative response.

The third skill we focused on was the ability to observe the immediate environment. This skill was driven by our desire to examine the usefulness of a head-tracking device during military training events. Our original idea was to incorporate situational awareness as an essential skill. We conducted an interview with the Naturalpoint TrackIR5 product manager at the Interservice/Industry Training, Simulation, and Education Conference (I/TSEC) and were told that gamers continually cited improved situational awareness as the main reason they purchase and recommend using a Naturalpoint TrackIR 5^{TM} head-tracking device. The challenge we encountered was defining situational awareness and then developing metrics. After debating the issue for quite a while, we decided to scope down the situational awareness skill to a much more definable and measurable ability: to observe the immediate environment.

After this analysis, we decided to focus on the following five skills during our scenario design.

- Individual movement
- Individual shooting a rifle
- Mounted HMMWV movement
- Mounted HMMWV shooting a M2 0.50 caliber machine gun
- Ability to observe the immediate environment

As described below (Table 1), each skill was measured by time to complete and by accuracy level.

2. Define the Movement Technique: Dismounted, Mounted, or Both?

Full spectrum operations today dictate that soldiers have the ability to wage war mounted and dismounted. In the 1980s and 90s, combat Soldiers were either considered 'heavy', mounted on vehicles, or 'light', dismounted and inserted via air platforms. The heavy community often integrated virtual training simulations into their unit training plans due to simulations huge cost saving. In the light community, training exercises are much less expensive, thus the cost saving is much less significant. This resulted in the heavy community embracing

simulations training technologies far more than the light community. This difference in cost savings has changed in recent years as wartime commanders look for every advantage in training their units for combat operations. This study will evaluate participants on both dismounted and mounted movement techniques.

C. PHASE II: DESIGN AND DEVELOP THE SCENARIO IN VBS2^{TM}

Once we had defined the problem, identified the critical skills sets, established measures of the chosen skill sets, and decided on the conceptual design of the scenario, we built the scenario into VBS2™. Special care was given to building the scenario. The scenario must first focus on the user skill gained during the initial training session. The scenario focused on the five skill listed above (individual dismounted movement (walking), mounted movement (driving), firing individual personnel weapon (M4 Rifle), firing crew served weapon (M2 .50 Cal Machine Gun), and situational awareness). The scenario must also be complex enough to cause participants' results to be reflective of their natural ability, gaming experience, and type of configuration. The distance and dispersion of the targets on the range must be varied from easy to hard. This manipulation should provide a challenge to all participants regardless of their gaming experience or VBS2™ configuration type, enabling us to capture real individual difference. Finally, the scenario must be simple enough to avoid introducing unnecessary sources of variation into the data. For example, adding agents representing civilians and insurgents might add reality and challenge but would likely introduce considerable noise to the data, so they were used sparingly. Finally, we avoided building tactics into the scenario to prevent prior knowledge of tactics from becoming an independent variable.

The course consists of a mounted vehicle movement portion followed by an individual dismounted movement portion (see Figure 9). The participant starts at a designated point, drives the vehicle through a serpentine course, and stops at battle position 1 of the mounted shooting range. There, the participant

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switches from the driver's seat to the gunner's station and engages three truck targets. Afterward, the participant returns to the driver's seat and continues on the driving course. The participant must negotiate a 90 degree left turn with buildings on both side of the road. Additionally, two civilian vehicles approach in this area, and the participant must negotiate around the traffic. Once through the built up area, the participant stops at battle position 2 of the mounted shooting range and engages an additional three truck targets. Once the engagement is complete, the participant continues on the movement course, negotiating two more civilian vehicles worth of traffic. At the end of the course, the participant combat parks the vehicle by backing it between traffic barriers and cones. Measures of performance include the following: number of vehicle collisions with scenery objects including traffic, number of times all four wheels of the vehicle went off the road, number of targets hit, number of rounds expended, and time for each portion of the course.
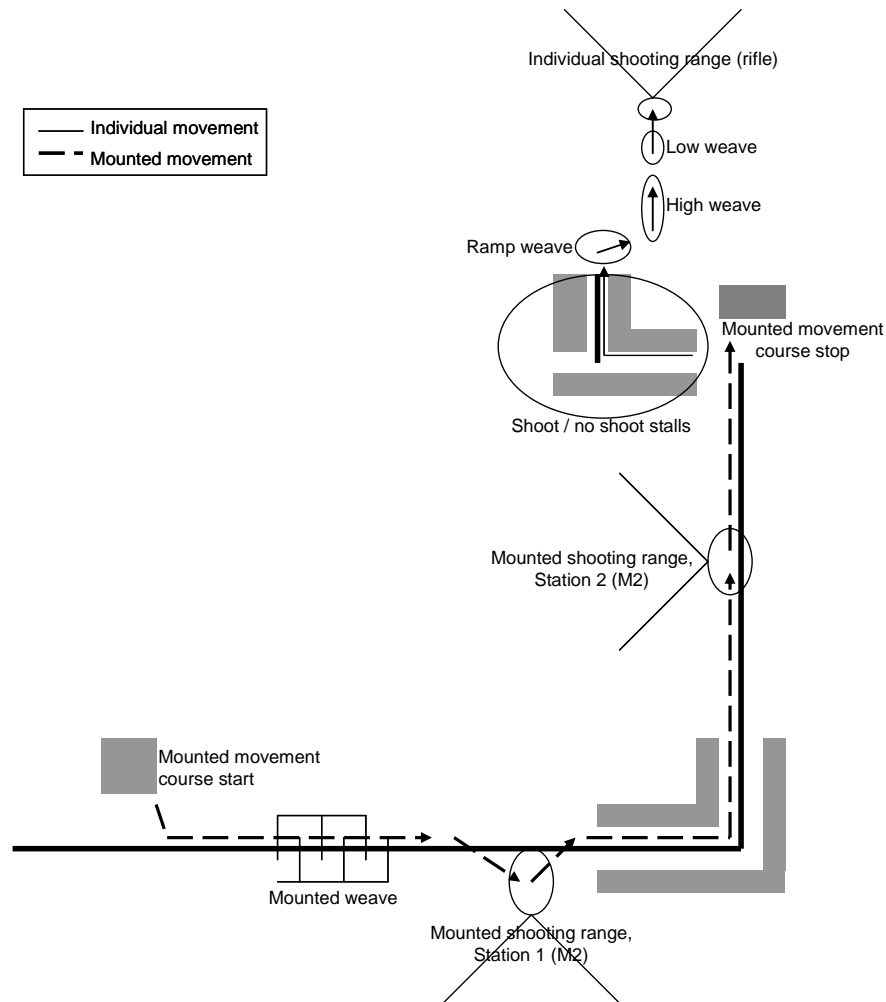
Figure 9.   A simplified schematic of the course scenario developed for the project.

The individual movement portion of the course starts when the participant dismounts from the parked vehicle. The participant walks into an arrangement of buildings that includes closed alleys. Each stall features either an enemy or friendly target. The twelve alleys are paired into six groups. In each pair, the alleys are on opposite sides of the road so that the participant must look fully to the left and to the right to determine which target to engage. Once participants completes the shoot / no shoot course, they negotiate the ramp weave course where they walk across elevated ramps arranged at different angles. Next, participants negotiate two weave courses. One has walls high enough that

participants cannot see over the top and have no awareness of their surroundings or direction. The other has low walls so that participants can see over the top of the whole course. At the end of the low weave, the participants low crawl through a tunnel, stand and run to the individual shooting range. There, participants engage personnel targets. Performance measures for the individual portion include: number of falls off the ramps, number of enemy targets hit, number of friendly targets hit, number of rounds expended, and time for each portion of the course. Table 1 summarizes the full interface evaluation course.

Station	Participant Action	Performance Measure
Mounted weave	Drive around barricades as quickly as possible without wrecking the vehicle	• Time • Number of vehicle crashes
Mounted shooting range, Station 1	Use the HMMWV M2 to destroy 3 enemy trucks	• Time • Number targets hit • Number rounds expended
Mounted shooting range, Station 2	Use the HMMWV M2 to destroy 3 enemy trucks	• Time • Number targets hit • Number rounds expended
Mounted movement	Move from mounted movement course start to stop, with time at mounted shooting range stations subtracted	• Time • Number scenery objects hit • Number times vehicle off road
Ability to observe	Combat park vehicle Conduct shoot / no shoot alleys	• Time • Number targets hit • Number friendlies hit
Individual movement	Move through ramp weave, high weave, and low weave	• Time • Number falls off ramp
Individual shooting range	Use the rifle to shoot 6 short range personnel targets and 3 long range popup targets	• Time • Number targets hit • Number rounds expended

Table 1.   Interface evaluation course station guide

To statistically compare the performance of various participants, the project proposes a scoring system that can be used to combine the various performance measures into quantifiable measures. Generally, the scoring system is divided into time portions and accuracy portions for each skill set. These scores will be normalized and used as the basis for analysis.

D.   PHASE III: DESIGN DATA COLLECTION SYSTEMS

1.   Introduction

We planned to gather our experimental data from three sources. The first was the initial survey of participants to establish a personal profile baseline. The second source came from using the After Action Review feature in VBS2^{TM} to evaluate the performance of the participants during the evaluated portion to the exercise. For example, we wanted to establish a scoring system that evaluates how long it takes participants to complete an obstacle course, how many times their vehicle leaves the road, and his performance on a weapons firing range with regards to time and accuracy. The final source was a second survey evaluating the training exercise.

2.   Surveys

Consistency plays a key role in the validity of subjective research assessments. One technique for achieving consistency involves automating the surveys. While automation introduces the potential for system error, it eliminates the possibility of human error. A well tuned automate survey system with low system error risk can dramatically improve the consistency of results, thereby contributing to a more solid analysis and better supported conclusion.

Previous MOVES experiments using Soldiers as participants and surveys to gather additional experimental data have fallen short of researcher expectations. The single biggest problem was with paper based surveys where participants failure to answer questions in a meaningful way. It was highly recommended that we avoid paper surveys and automate the survey process because it greatly improves the quality of our survey data.

Automating the survey process serves several purposes. First, if forces participants to answer the question, even if it is only "I do not wish to answer this question". Second, it provides the ability to categorize answers and conduct error checking. For example, if asked "how many years have you played video games" an answer of '71' would send the user into a loop until he entered

correctly entered '17'. Finally, an automated survey could produce a text file that could easily be imported into our statistical software package.

We used three surveys to gather demographic data and preference data. The first survey was a pre-exercise survey designed to gather demographic data on the participants. The second was a post-exercise survey completed after the first run to gather participant preference data on the user initial input configuration. The third survey was a post-exercise survey completed after the final run. It asked the same questions as the first post-exercise survey but added some additional questions focused on identifying participant preference between the two configurations.

3. Automated Scoring System

a. *Introduction*

As mentioned in the previous section, consistency plays an important role in the validity of objective research assessments. A second technique for achieving consistency involves automating the scoring process as much as possible. Our method used Java code to read VBS2^{TM} data packets to automate the scoring process.

Calytrix Technologies worked with Bohemia Interactive to develop supplemental software for VBS2^{TM} to communicate with other military simulation products. The United States military has adopted two protocol standards for simulations: Distributed Interactive Simulation (DIS) and High Level Architecture (HLA). The Calytrix product LVC Game supports both protocols, enabling VBS2^{TM} to communicate via DIS or HLA.

DIS uses User Datagram Protocol (UDP) to facilitate communications. UDP involves sending packets across a network in an unsupervised fashion. UDP packets may arrive in duplicate, may not arrive at all, or may arrive out of order. However, because UDP packets flow as quickly as sender and receiver can operate, it is ideal for the world of game applications where activity is constant. While DIS is a complex domain in military simulation,

the concept is quite simple. DIS provides a coding system for UDP packets. The Simulation Interoperability Standards Organization (SISO) maintains a codebook for DIS. Assuming everyone involved adheres to the SISO standards, any DIS user can communicate to another across any network regardless of platform or gaming application. DIS has been used successfully for more than a decade, and international partners have adopted the standard in order to use simulation in joint training. The concept of DIS is alive and well, providing a dependable means of communicating with VBS2^{TM}.

b.   Method

This project sought to use Java code to read DIS packets from VBS2^{TM} and interpret the information into viable information for performance measures. We used an open source library called Open-DIS, developed and maintained at the Naval Postgraduate School, to process DIS PDU's into Java objects for easy manipulation. The project started by reading DIS packets from the game in a simple scenario. Once the general content of the VBS2^{TM} DIS packets was evaluated, ad hoc methods of using VBS2^{TM} scenario editing were developed in order to achieve the goals of the various performance measures. Initial project analysis dictated the ability to do the following tasks:

- Detect target hits;
- Detect number of rounds fired;
- Record times of various events;
- Detect collisions.

c.   Determine What Information VBS2^{TM} Packets Could Provide

DIS data packets are called Protocol Data Units (PDUs). DIS offers a variety of PDU types, and the PDU type is the fundamental component of message decoding. Depending on the PDU type, all other information in the packet has a certain distinct meaning. Up front, we identified four PDU types of potential interest to this project: Entity State, Fire, Detonation, and Collision. We

used a simple scenario to determine which PDUs we could detect from VBS2™. After maneuvering and shooting both mounted and dismounted, we determined that we could detect entity state, fire, and detonation PDUs. We could not detect collision PDUs. As a result we determined that detecting vehicle collisions with scenery objects or traffic and individual falls off the ramps would not be possible. Additionally, we determined that none of the PDUs could be effectively used to determine if a vehicle ran all four wheels off the road. Because these three measures could be detected in after action review footage, we determined that they would have to be human evaluated.

In our evaluation of the PDUs, we determined that the following information could be exploited for our project. All PDUs included a time stamp that made time determinations relatively straightforward. Entity state PDUs included a variety of coded information such as platform name and country of origin. Fire PDUs allowed access to this entity state information for the shooter, while detonation PDUs allowed access to entity state information for the target. Each game entity has a unique identification number called the Entity Identification (ID). The Entity ID is a key piece of data, but it is randomly assigned for each scenario run, so the tag cannot be hard coded.

We were able to use a combination of the entity state, fire, and detonation PDUs to accomplish all of the performance objective goals related to shooting. However, getting the exact information required some ingenuity and imagination.

d. Recording Shooting Information

We could easily record the number of rifle rounds fired because only the rifle produced fire PDUs. Recording the number of expended rifle rounds was simply a matter of counting fire PDUs. Recording the number of machine gun rounds expended was a little less straightforward because the machine gun only produced detonation PDUs. Fortunately, every round produced a detonation PDU, so the process resulted in simply counting all

detonation PDUs, determining which denotation PDUs had been caused by a rifle, and subtracting to yield detonation PDUs caused by a machine gun.

Recording target hits was a little less evident. The process was complicated by the fact that we sought to be able to distinguish between vehicle, personnel, popup, and friendly targets. An additional challenge arose because a training portion of the scenario that was not evaluated at all included similar vehicle and popup targets. We also wanted to record target hits only once. That is, the code needed to discern when a target had been hit and never record hits on that target again. We detected target hits through the detonation PDUs. Detonation PDUs provided both Entity ID and entity state information.

The coding and registration process adequately facilitated recording target hits. A detonation PDU provided Entity ID and entity state. If the entity state had a country code matching the target range, we looped through the target array looking for the Entity ID. If a match was achieved, we checked to see if the target had already been recorded as a hit. If it was still coded zero, it was coded as hit with a one, and recorded the appropriate hit. We used unique country codes to distinguish between vehicle, personnel, popup, and friendly targets so that we could record hits for each group separately.

e. Recording Time Information

Recording the time of individual target hits was quite straightforward. Using the target information discussed above, we knew the detonation PDU that indicated a target hit. Recording the target hit was reduced to simply recording the time stamp from that detonation PDU.

Determining the time that the participant started each specific course station was much less to the point. The VBS2^{TM} trigger presented the obvious opportunity to record such information. The trigger allows the editor to supply any viable VBS2^{TM} command through the game's scripting language. Use of triggers can be extremely simple; for example, the presence of a friendly entity can set off the trigger. Unfortunately, the trigger itself does not send a PDU of

any sort. Thus, we had to develop a way to get a trigger to send a PDU. We developed a list of eleven triggers (listed in Table 2) that would provide the necessary timing information.

We decided to use the fire PDU as a mechanism for passing trigger information. We created a set of unique individual characters. We gave each unique character type an individual country code between 20 and 45. We gave each character a unique name, calling them Trigger1 through Trigger11. In the initialization phase of the program, we registered the triggers in the same way we registered targets as described above. While watching entity state PDUs, we looked for entities that matched the trigger country code range and recorded the entity ID and country code in an array if it had not already been recorded. We could then place triggers at the appropriate points in the scenario to note station transition times. We used the scripting language in each trigger to make a unique trigger character fire. This scripting code required the name of the character and the nomenclature of the character's weapon. By matching entity IDs, we could use the fire PDUs to determine the unique country code of the firing individual. We could then match this country code to the specific trigger and record exactly where the participant was. As in other cases, we used the fire PDUs time stamp to record when the participant tripped the trigger. Appendix A lists all the coding information used for these triggers.

1	Enter mounted movement course / course start
2	Mounted weave start
3	Mounted weave end
4	Enter mounted shooting range, Station 1
5	Exit mounted shooting range, Station 1
6	Enter mounted shooting range, Station 1
7	Exit mounted shooting range, Station 2
8	Exit mounted movement course
9	Exit shoot / no shoot stalls
10	Enter individual shooting range
11	Exit individual shooting range / course end

Table 2.   Triggers used for timing calculations

f.   Implemented

The interface scoring system implemented in Java using Open-DIS adequately recorded objective performance information for all time and shooting criteria.   We could find no way to use DIS to record vehicle collisions with scenery objects, vehicle deviations from the road, or individual falls off the ramps. Table 3 summarizes the performance measures recorded by the interface scoring system.

Station	Performance Measure	Recording Method
Mounted weave	• Time	Time stamp from trigger fire PDU
Mounted shooting range, Station 1	• Time • Number targets hit • Number rounds expended	Time stamp from tgt detonation PDU Detonation PDU entity information Detonation PDU count
Mounted shooting range, Station 2	• Time • Number targets hit • Number rounds expended	Time stamp from tgt detonation PDU Detonation PDU entity information Detonation PDU count
Mounted movement	• Time • Number scenery objects hit • Number times vehicle off road	Time stamp from trigger fire PDU Not recorded Not recorded
Situational awareness	• Time • Number targets hit • Number friendlies hit	Time stamp from trigger fire PDU Fire PDU target information Fire PDU target information
Individual movement	• Time • Number falls off ramp	Time stamp from trigger fire PDU Not recorded
Individual shooting range	• Time • Number targets hit • Number rounds expended	Time stamp from tgt detonation PDU Detonation PDU entity information Fire PDU count

Table 3.   Interface scoring system performance measure summary

4.   Manual Collection System

As previously, mentioned the automated scoring application could not collect all the scores to adequately evaluate participant performance. Specifically, we could not detect collision PDUs. As a result, we determined that detecting vehicle collisions with scenery objects or traffic and individual falls off the ramps would not be possible. Additionally, we determined that none of the PDUs could be effectively used to determine whether a vehicle ran all four wheels off the road. Finally, the vehicle parking event scoring was also outside the capability of our automated scoring application. Therefore, we determined that they would have to be evaluated by someone watching the after action review video.

This evaluation was conducted by a research assistant. He was trained on the basic capabilities of VBS2^{TM} and how to evaluate participant runs and record results. His deliverable was a spreadsheet cataloging the participant number and corresponding event scores.

The research assistant was provided a VBS2^{TM} laptop computer system and a portable hard drive containing all the after action review video files for each participant. There was no personally identifiable information (PII) on the portable hard drive. He would move the AAR video files from the portable hard drive into a folder that could be accessed by the VBS2^{TM} and then load up VBS2^{TM}. Then he would follow the AAR Evaluation Instructions found in Appendix E. When he completed the evaluation of all participant AAR he provided us a detailed spreadsheet with all the scoring data required to conduct our statistical analysis.

IV.   PILOT STUDY

A.   INTRODUCTION

1.   Background

A pilot study was conducted to gather preliminary data addressing the main research question and to refine procedures and logic of the main study. In this pilot study, performance with the standard keyboard and mouse was compared to performance with the Play Station 3 (PS3) game controller. Subjective preference also was assessed.

2.   Research Questions

This pilot study addresses these issues by comparing the standard keyboard and mouse interface to the game controller interface on user preference and objective performance measures. It specifically address the following questions:

1. Do user-input devices impact military training performance when used with a desktop virtual training simulation?

2. Do soldiers prefer one user-input device over another when using a desktop virtual training simulation?

3.   Hypothesis

The addition of a commercial game controller device to virtual desktop simulations will improve performance in a virtual training simulation and be preferred over the standard keyboard and mouse.

4.   Scope

As this was the pilot study for the main study, we needed to scope the project to focus on the most problematic aspects of the experiment: testing our methods, procedures, and logic by comparing the standard keyboard and mouse configuration and the PS3 game controller. Specifically, it focuses on individual

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mounted and dismounted movement within the VBS2^{TM} virtual training environment. It also focuses on the ability to accurately identify and engage targets with personal and crew served weapons. If the design of the experiment is sufficient to demonstrate a difference between these two interfaces, then we will add an optical head-tracking device that allows participants to observe peripheral views outside the laptop window screen by simply turning their heads.

B. METHOD

1. Participants

NPS students and faculty participated in the simulation experiment. There were three different sessions. In the first session, participants were 16 first year NPS MOVES students enrolled in an introduction virtual systems course.

The second session consisted of the previous 16 students and an additional 10 students and faculty who participate in the MOVES weekly brown bag seminar. The additional participants gave us a greater opportunity to test our methods, procedures, and logic on a larger sample size. The original 16 students were the focus of the 2nd session since they had participated in the first session. We did this so we could use a within subjects design to evaluate performance with two different VBS2^{TM} configurations.

The 16 primary participants were officers ranging from O-1 2nd Lieutenants (or Lieutenant JG) to O-5 Lieutenant Colonels. The average age was 32.1 (4.4), with a range between 27 and 42. None were female. Seven of the 16 (44 percent) identified themselves as "Gamers". This 44 percent is much higher than typically found in the U.S. Army. According to Atkinson-Bonasio (2008) about "50 percent of young enlisted Soldiers call themselves "gamers" or are familiar with the mechanics of game play. At the officer level it is around 33 percent." This difference was to be expected because the participants were students at the MOVES Institute at NPS and this curriculum is likely to draw someone who plays video games in their free time.

2. Measures and Equipment

The project used 16 Dell Precision M6300 laptops from a suite of the Marine Corps Deployable Virtual Training Environment (DVTE) package. Peripheral equipment, including mice, cables, and switches, came from the standard DVTE package. We networked all sixteen computers together with different environments using four D-LINK DGS-2208 port switches. This allowed us to push configuration files and download participant data results from one central location. Participants operated as individuals in the evaluation.

The hardware and software was configured by the participants when they arrived at the MOVES classroom. The participants unloaded the laptops from the DVTE boxes and physically networked the computers together. They then received a brief where they uploaded the required software and configured their systems. This included but was not limited to configuring the time, graphics display, VBS2^{TM} profile, scenario, InterfaceLib, batch files, DIS deploy, disEntity and VBSEntity config files. The participants then installed and configured the NaturalPoint TrackIR5^{TM} and SixAxis^{TM} PS3^{TM} interpreter software and drivers. The instruction for this procedure are listed in Appendix E. DLI Study Computer Setup.

The last step was to start the scoring, survey, and VBS2^{TM} software. First, we started the VBS2^{TM} software, verify settings, and upload the experimental training and evaluation scenario. Next, VBS2^{TM} was minimized and the Java JAR file was started to administer the survey and record the scoring data. This resulted in all the required software running in the background and the first survey question waiting to be answered by the participant.

We used three surveys to gather demographic data and preference data. The first survey was a pre-exercise survey designed to gather demographic data on the participants. The second was a post-exercise survey completed after the first run to gather participant preference data on the user initial input configuration. The third survey was a post-exercise survey completed after the

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final run. It asked the same questions as the first post-exercise survey but added some additional questions focused on identifying participant preference between the two configurations.

3. Procedure

a. First Session

The participants were first briefed on the purpose and generic details of the study. It was our intent to completely inform the participants of all details of the experiment. There was nothing to be gained by limiting their knowledge of the experiment. The participants were then instructed to read the institutional review board (IRB) documentation and sign the IRB informed consent (Appendix A) stating they were willing participants. There were no balks at signing the IRB statement.

After signing the IRB statement, the participants completed a demographic survey administered by our automated survey program. A paper version of the demographic survey used for the pilot study is included in Appendix E.

When everyone completed the automated demographic survey, we began the training session. The training session consisted of an information brief followed by a hands on exercise on how to use the standard keyboard and mouse to move and shoot in the VBS2^{TM}. Once each participant had successfully completed each training task, they were shown a video of a successful run on the test course. Again, nothing was to be gained by keeping any aspect of the test course a secret. This was an open book test where the limiting factor was the user-input device not knowledge of the test. This included a detailed discussion on exactly how their performance would be measured.

Figure 10.   Classroom setup for keyboard and mouse session

The participants were then instructed to complete the test course as quickly and accurately as possible. After the participants completed the test course, an automated trigger closed down VBS2™ and opened a post exercise survey. When they completed the post exercise survey they were released for the day.

Later, we downloaded all demographic and post survey text files, the automated scoring text file, and the after action review video file. We also reconfigured the workstations to support using the PS3 game controller as the primary user-input device.

b.   Second Session

Two weeks later, the participants returned, received an abbreviated brief, and reviewed and signed the IRB informed consent paperwork. They received a second training session using the game controller as the primary user-input device. Then the participants were tested on the same test course

using the game controller instead of the standard keyboard and mouse configuration. Upon completion of the test course, an automated trigger closed the VBS2^{TM} application and opened a slightly different post-exercise survey. It asked the same questions as the first post-exercise survey but added some additional questions focused on identifying participant preference between the two configurations.

Figure 11.   Classroom setup for PS3 game controller session

During the second session, the participants ran out of time to complete the experiment. This was a problem but not catastrophic. We were able to retrieve three of the four data sets required to conduct analysis. We were also able to retrieve the pre and post-surveys and the after action review video from each participant. Unfortunately, the scoring interface text file that records the trigger times, target times, and ammunition expenditures were lost. This resulted in a third session where the original 16 MOVES student participants reran the evaluation portion of the experiment.

c. Third Session

One week later, the original 16 MOVES student participants returned to rerun the evaluation test course. When they arrived, they reviewed and signed the IRB informed consent paperwork. They received no briefings or any additional training. They completed an abbreviated pre-survey for tracking purposes only because we already had their pre-survey data from earlier experiments. Then, the participants were tested on the same test course using the game controller. Upon completion of the test course, a automated trigger closed the VBS2^{TM} application and opened the slightly different post-exercise survey described above in 'Second Session. Finally, we downloaded all survey and scoring data and returned the VBS2^{TM} and the DVTE laptops to their baseline configurations.

C. RESULTS

1. Evaluate the Experimental Data

We used a significance level of 0.05 for all analysis. The first statistical analysis we conducted was a paired t-test comparing the number of M2 and M4 rounds expended during the evaluated exercise.

H_0: The change in the user-input configuration from keyboard and mouse to game controller did not change the mean number of rounds expended ($\mu_d = 0$).

H_a: The change in the user-input configuration from keyboard and mouse to game controller did change the mean number of rounds expended ($\mu_d \neq 0$).

Weapon	Sample Size	KB Mean (SD)	GC Mean (SD)	t-test	p-value
M4 Rds	13	54.1 (17.5)	41.9 (27.1)	1.24	0.23
M2 Rds	13	434.7 (212.6)	557.1 (292.7)	-1.24	0.23

Table 4.   Mean with standard deviation (SD) of rounds needed to complete weapons engagements with keyboard (KB) and game controller (GC)

The p-values are large, so we retain the null hypothesis and conclude that there is no difference between configurations when using the number of rounds fired as a measure of effectiveness for both M4 and M2.

The second statistical analysis we conducted was a paired *t*-test comparing the amount of time required to effectively engage required targets in the shoot / no shoot lane with the M4 rifle and the Battle Positions with the M2 heavy machine gun.

H_0: The change in the user-input configuration from keyboard and mouse to game controller did not change the time required to effectively engage required targets ($\mu_d = 0$).

H_a: The change in the user-input configuration from keyboard and mouse to game controller did change time required to effectively engage required targets ($\mu_d \neq 0$).

Weapon	Sample Size	KB Mean (SD)	GC Mean (SD)	t-test	p-value
M4 Range	13	63.9 (13.6)	34.3 (7.3)	8.55	<0.001
M2 Range	13	169.5 (13.0)	102.2 (55.9)	3.32	0.006

Table 5.   Time required to complete weapons engagements (Time)

The P-value is well below our α of 0.05, so we reject the null hypothesis and conclude that the change in user-input configurations did lead to a change in time required to effectively engage required targets.

These first two tests had no credibility. How could there be such a big difference between these two measures of effectiveness, which are essentially measuring the same thing? When we dug a little deeper, we found that our automated scoring application was correctly capturing the time data but incorrectly capturing the number of rounds fired. It was an error in our automated

scoring application source code. The details of the coding error and our solution is fully discussed in the next section "Evaluating the study's logic and effectiveness."

The third statistical test we conducted was a paired *t*-test comparing the amount of time required to complete the mounted and dismounted portions of the test course.

H_0: The change in the user-input configuration from keyboard and mouse to PS3 game controller did not change the time required to complete the test course ($\mu_d = 0$).

H_a: The change in the user-input configuration from keyboard and mouse to PS3 game controller did change time required to complete the test course ($\mu_d \neq 0$).

Weapon	Sample Size	KB Mean (SD)	GC Mean (SD)	t-test	p-value
Mounted	13	103.8 (17.9)	49.1 (8.7)	10.15	<0.001
Dismounted	13	133.6 (25.8)	83.81 (29.1)	4.25	0.001

Table 6.   Time required to complete the test course (Time)

The P-value is small, so we reject the null hypothesis and conclude that the change in user-input configurations did lead to a change in time required to complete the test course for mounted and dismounted.

2.   Evaluate the Study's Logic and Effectiveness

a.   Surveys

Previous NPS VBS2™ thesis experiments used paper surveys that allowed participants to simply not complete the questions resulting in large gaps in data for analysis. As a result, it was highly recommended that we use an automated survey that required participants to enter meaningful answers, even if the entry is "do not care to respond". When we coded the Java JAR file, we

added error checking within the methods asking the questions to prevent erroneous inputs. The JAR file created to gather survey information was successful but far from perfect. In the first session we identified that some of the error checking did not allow for legitimate answers in the pre survey used to collect demographic data. It was a simple fix to adjust the values used in error checking.

The second issue was that participants who did not want to answer a question could close the dialog box and continue with the survey as stated in the IRB approved consent form. This completely defeats the purpose of the automated survey. The issue arose when the participants closed the dialog box the method threw an exception error and bypassed the error checking. The solution was to add an error checking statement outside the method that sends the participant into a continuous loop until appropriate data is entered.

The final lesson learned in regards to the survey was a reoccurring theme in the pilot study and probably the most important lesson learned. We overestimated the time required for participants to complete required tasks. It always took longer to complete any task than expected. There were three reasons for this planning error. The first reason was that we, as the researchers, were too close to the problem to accurately estimate the capabilities of a participant who had never seen the problem. Secondly, we used the expected average time a participant would require to complete the task as a planning factor. In reality, we should have used the expected time for the slowest participant to complete a task as a planning factor. The final reason was that we were not exactly sure how best to conduct the experiment, so we purposefully errored on the side of more detail instead of less detail. It is always easier and safer to take out aspects of the experiment after the pilot study than to add additional requirements. The pre and post-surveys were both longer than necessary and were streamlined for the main study.

b.   Project, VBS2 *™, Training, and Evaluation Course Briefs*

The next set of lessons involved the briefing the participants received from the researchers. The briefing was too long and did not include some important pieces of information. These lessons were identified by the participants after the exercise during a question and answer period. The brief originally provided an overview of commands used to control the participant's avatar with the keyboard or PS3 game controller. Afterward, the participant conducted a hands-on training exercise. This hands-on training exercise was determined to be redundant and confusing. We consolidated the overview brief and hands-on training exercise resulting in a more efficient and effective training session. The same problem was identified when preparing the participants to conduct the evaluation portion of the experiment. The participants were provided an overview brief describing the evaluated events and how they would be scored. Then they were shown a video of what the correct performance looks like. Again, the participants identified this as redundant and it was consolidated.

After we completed each pilot study session, we conducted an after action review with the participants that provided valuable insight into what was missing from the briefing. The participants recommended that we include a picture of each target during the overview briefs. There initially was some confusion on the difference between enemy and friendly targets during the shoot/no shoot lane. The blue targets were designated as friendly and the green targets with yellow Xs were designated as enemy. There was also confusion on what constituted a hit when engaging the insurgent targets. Sometimes the insurgents were wounded, but did not die. The wounded insurgents are registered as target hits in the automated scoring application. Participants repeatedly asked about vehicle rear view mirrors and if the user's vehicle can become inoperable due to sustaining damage. There are no rear view mirrors and the vehicles can become inoperable during the conduct of the training and evaluation exercise. The participants recommended that we clarify these vehicle

limitations in the overview brief. We also added a hidden spare vehicle in the training scenario in case a participant's vehicle became inoperable.

c. Keyboard and Game Controller Function Mapping

We also learned a lot about the mapping of the functions to the keyboard and game controller controls. Our intent was to limit the commands to only what was necessary to complete the evaluation portion of the experiment. In the first session, we included the 'toggle weapons' command. The 'toggle weapons' command enables participants to change their weapons from semi-automatic, to burst, or use grenades. This command confused the participants and provided no value to the exercise as we want the user to only use semi-automatic. We removed the 'toggle weapons' command to prevent the confusion.

The second issue was that there is a 'free look' option that was not made available to participants. In planning, we did not think it was necessary. The 'free look' functionality enables the player to look freely around the environment without changing the orientation of the body. It allows the player to move their head but not their body. This is particularly useful when driving a vehicle because it allows the player to look outside and through back windows. The TrackIR: 5 Head Tracker maps to this specific functionality. After reviewing the performance of the participants on the combat parking event, we saw that this command would provide value to participants during the combat parking event. Furthermore, it would be disingenuous to introduce the TrackIR: 5 Head Tracker capability and not allow the same capability within the keyboard and game controller configurations. We added the 'free look' functionality to the PS3 game controller by mapping it to the Circle button. This was a better solution but not quite right. During the PS3 game controller session, participants would unknowingly hit the circle button and activate the 'free look' functionality. This completely disoriented the participant. The circle button is on the far right side of the controller and located directly under the thumb. This location often resulted

in the accidental activation of the circle button. This problem is further exacerbated because the participant's screen does not change when the button is pressed and goes unnoticed until the participant attempts to fire their weapons. We moved the mapping of the 'free look' to the square button. This button is towards center of the game controller and is less likely to get accidently pressed.

The third issue was raised by participants who spend an exorbitant amount of time playing video games, and have very specific preferences. They asked about the ability to change the PS3 game controller to "inverted." We did not know about inverted controls so we did not implement this functionality. Inverted controls is a setting that enables you to press down and look up or vice versa. According to our participants and Andy Robertson of GamePeople, once a gamer discovers inverted controls "there is no going back for these gamers, it becomes so engrained in their playing psyche that any game without it became almost unplayable" (Robertson 2006). Our participants agreed. One of our participants compared it to being left or right handed. He also added that an experienced gamer might actually perform worse than a novice if not provided with an inverse controls option.The following is an excerpt from an Andy Robertson 2006 article explaining why some gamers have such strong opinions on inverted controls.

"The question is where does the player put their consciousness in relation to the controller. What part of their body is the joypad controlling, their arm, their head; and how is this control translated to that body part" (Robertson 2006).
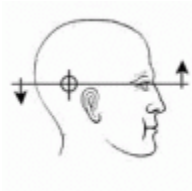
Behind: If the player feels they are controlling movement from behind their head with joypad , they are likely to find an inverted control scheme works best for them. Pulling back on their stick therefore tilts their head up and should move the play field up.

Figure 12.   Behind (From Robertson, 2006).
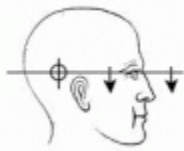
In front: If the player feels they are controlling movement in front of their head, they are likely to find a non-inverted control scheme works best for them. Pulling back on their stick therefore pulls their head down from the front and should move the play field down.

Figure 13.   In front (From Robertson, 2006).

Robertson hypothesizes that extroverted players prefer the feeling of controlling the gamer in front of themselves. Whereas an introverted player would prefer to control the game from a safe location behind themselves. There seems to be no right answer but only an issue of individual preference. Some of our participants believed that pilots and gamers who play flight simulations games prefer inverted controls because it is more representative to aircraft controls. Regardless of the reason, we introduced inverted controls in the main study as an option as not to hinder gamers performance in this segment.

d.   After Action Review Recording

The first session of the pilot study also reinforced a lesson we had learned from earlier experiments. The more you can automate the better. Every time a researcher depends on the participant to manually perform a task essential to the experiment, there is a huge risk for problems.   When we designed the experiment, we automated the pre and post surveys, the scoring application, and the start of the after action review video recording. We were not able to automate the saving of the after action review video recording and depended on the participants to save this file at the end of the session. As a result, we lost nearly 20 percent of the recorded after action review videos. We contacted the VBS2™ technical assistance and after numerous emails, we discovered a procedure that automated the saving of the after action review video file. The procedure involved linking a VBS2™ trigger to a script that saved the after action review without placing any requirement on the participant. This

should have been an easy fix but their recommended solution did not work on our system and instead presented another learning opportunity.

e VBS2^{TM} Version Control

The next learning "opportunity" concerns VBS2^{TM} software version control. There are at least 3 versions of the VBS2^{TM} software in the military today. VBS2^{TM} (version 2.21) was originally delivered to the U.S. Marine Corps as part of the Deployable Virtual Training Environment (DVTE) Suite. This version has a Hardware-Assisted Software Protection (HASP) Key issue that results in VBS2^{TM} randomly failing. We have had five of the 32 DVTE laptops fail due to this HASP Key error. The U.S. Marine Corps and Bohemia Interactive are well aware of the problem and provided us a solution. Their recommended solution was to reinstall the entire hard drive with a clean image of the DVTE software suite. This solution was not optimal but we had no choice. We also had no removable hard drive with a clean DVTE master upload image to fix the laptops that failed due to the HASP Key error. We obtained a clean DVTE master upload image on a removable hard drive from the USMC Program Manger of Training Systems.

After receiving the removable hard drive with the clean DVTE image we reinstalled the DVTE software upload onto the failing laptops. This fixed the HASP Key error. The new DVTE software suite was delivered with VBS2^{TM} (version 1.3). This version has all the basic startup modes such as VBS2^{TM} User, VBS2^{TM} Administrator, and VBS2^{TM} Windowed. But, it did not have VBS2^{TM} LVC Game. We needed VBS2^{TM} LVC Game. The VBS2^{TM} LVC Game includes the Calytrix add on that provides a bi-direction DIS/HLA gateway for connecting VBS2^{TM} into existing defense simulations systems such as Joint Conflict and Tactical Simulation (JCATS), Joint Semi-Automated Forces (JSAF), or One Semi-Automated Forces (OneSAF) (see Figure 14).
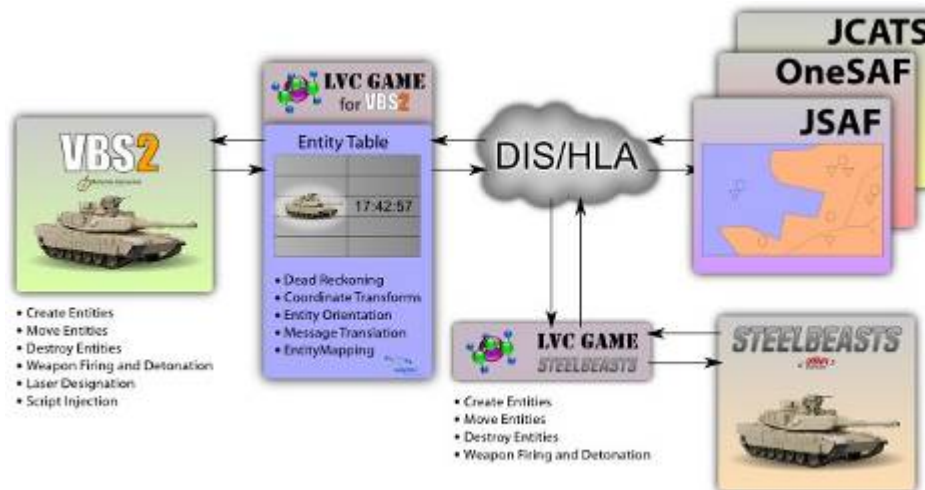
Figure 14.   VBS2^{TM} Network Diagram. (From VBS2^{TM} Users Manual, 2010)

We needed the VBS2TM LVC Game because it is the only start up mode that produces and sends out the DIS packets to a network. Our automated scoring applications captures these DIS packets and then outputs the data to a text file that is later used to score the participant's evaluation run. Without this capability, we would need to manually score each individual run by observing the recorded after action review. This was a viable backup but extremely time consuming. It would introduce human error into our data that the automated scoring system would prevent. We needed to find a better way.

In early 2009, the U.S. Army also purchased the rights to VBS2TM and is currently fielding it to the force. We requested and received VBS2TM (version 1.23) from the U.S. Army's National Simulation Center (NSC) in late 2009. We installed it on one DVTE system and found it essentially the same as the U.S. Marine Corps version 1.21 but with a more robust PBO library. The PBO library contains the 3 dimensional characters, vehicles, weapons, and building with their associated database of performance parameters. We originally decided not to upgrade the U.S. Marine Corps' VBS2TM (version 1.21) with the U.S. Army's VBS2TM (version 1.23) because we did not believe the value of the additional PBO library outweighed the risk associated with uploading a new version of VBS2TM. After all, the U.S. Marine Corps's VBS2TM (version 2.21)

was working well. This all changed when we received the clean DVTE master upload containing the new VBS2TM (version 1.3) that did not possess the VBS2TM LVC Game. We decided to assume the risk and upload the DVTE systems with the U.S. Army's VBS2TM (version 2.23) with LVC Game.

The VBS2^{TM}: Army (version 2.23) fixed two persisting problems. First, it had the VBS2^{TM} LVC Game to run our scoring application. Secondly, the VBS2:Army^{TM} (version 2.23) also fixed the challenge of automating the saving procedure of the recorded after action review files. The reason the Bohemia Interactive technical support solution did not work on our system was because we were using two different version of VBS2^{TM}. Once we upgraded to the newer version, their recommended solution worked perfectly.

One of the drawbacks of upgrading versions was the compatibility of our VBS2^{TM} training scenario file. The training scenario file we built using the original VBS2^{TM} (version 1.21), did not transfer perfectly to the upgraded VBS2^{TM} (version 1.23). This did not require a complete rebuild but did require significant trial and error to find the differences. A few examples of the differences were links between some actions and triggers that were broken, some objects were not "snapped to surface" (flush with the ground), and a few objects were repositioned or looked different. None of these were difficult to fix, but all were a challenge to find.

f. *Automated Scoring Application*

The application created to gather data during the exercise worked well but was not perfect. The scoring application accurately captured all the targets and trigger times required to conduct our analysis but it did not accurately capture the number of M4 rifle rounds fired or M2 machinegun rounds fired. We examined the code and discovered we were counting the number of rounds fired in both the training and evaluation phases of the experiment. We removed the code that counted rounds expended from the training phase. This fixed the M4 rifle counting problem but not the M2 machinegun round count problem.

The M2 problem was caused by how DIS packets are sent over the network. M4 rifle DIS packets are coded as "fire" PDU whereas the M2 dis packets are coded as "detonation" PDU. We were able to capture and count the M4 "fire" PDU but we could not do the same for M2 "detonation" PDUs because there were too many events that produced "detonation" that we could not sort through all the "detonations" and accurately extract only the detonations produced by firing with the M2. After considerable discussion, we decided that this was not actually a problem. The M4 rifle is a precision weapon and counting rounds is important, whereas the M2 heavy machine gun is an area fire weapon where time, not rounds expended, is the accepted measure of effectiveness.

g.   The VBS2^{TM} Training and Evaluation Courses

There were more lessons learned but the last set of lessons we will discuss here was with the VBS2^{TM} training scenario file itself. This is the actual virtual environment we created using the VBS2^{TM} mission editor to train and evaluate our participants. Most of these issues were found during the analysis of the data. First, the most challenging portion of the course was the combat parking lane. It was first deemed too difficult, and then we realized that we trained every task except combat parking. The solution was to add a combat parking lane at the end of the training session in order to allow participants to practice this task at least once before proceeding to the evaluated exercise.

The second lesson was in the shoot / no shoot lane in which participants were to walk down a city street and engage four enemy targets, then make a right hand turn, and engage another two enemy targets. Nearly 40 percent of the participants made the right hand turn when they saw the ramp lane with green arrows and bypassed the two last targets. Because of this problem and for the sake of saving time, we removed the last two shoot / no shoot engagements. We also received feedback from participants stating that the task was too repetitive; they indicated they had achieved their purpose with the first four engagements, and thus, the last two were unnecessary.

The other problem with the shoot/no shoot lane was that we had no time trigger between the combat parking lane and the shoot / no shoot lane. Therefore, we could not establish a start time for the dismounted portion of the course. We adjusted one of the time triggers to fix this problem.

In the first session, two participants got lost at the transition point. As a result, the obstacle course was painstakingly designed to prevent participants from getting lost. The participants were essentially boxed into the scenario, and not given the opportunity to leave the desired route. The one exception was at the transition point where the participant exits the vehicle and begins the dismounted portion of the exercise. The two participants who got lost took the same wrong road at the transition point. This was fixed by emplacing a series of 15-foot T-wall barricades to block participants from getting off the desired route.

The last problem was with the final three targets on the M4 rifle range. The distance to the targets were too great to effectively engage with the PS3 game controller and they were very difficult to identify. We fixed this by moving the targets in about 40 meters and placing yellow range fans on the left and right limits of the range. We also created range fans to the training M4 rifle range and moved some of the practice targets further away to provide a better training opportunity for the participants.

D.   DISCUSSION

The results of the study demonstrated that several logistical issues had to be resolved, but that our logic was sound and the PS3 game controller was a superior user-input device. One factor that we did not control for was sequence. All of our participants first used the keyboard and mouse configuration followed by the game controller configuration. What we did not uncover, was how much the sequence skewed our data; but we suspect it had a significant effect. This resulted in a change in the design of our experiment to incorporate the sequence as an independent variable.

We believe that this pilot study was successful by gathering sufficient information to test the logic of our study. It also provided insight to where our logic and execution was flawed. Finally, it provided us with an abundance of lessons learned that, when incorporated into our larger thesis study, will improve the quality and efficiency of the research.

V. DEFENSE LANGUAGE INSTITUTE USER-INPUT DEVICE EXPERIMENT

A. BACKGROUND

1. Introduction

The purpose of the Defense Language Institute (DLI) experiment was to evaluate the performance and preferences of Soldiers using different user-input devices. All of the lessons learned during the pilot study, described in Chapter IV were corrected for this experiment. Through coordination with the 229th Military Intelligence Battalion Commander and his operations officer, we were able to conduct our experiment on a sample from the population of interest: young active duty Soldiers.

The study required that two experiments be run simultaneously. The only difference between the two experiments was how the user-input device configuration varied. The first experiment was designed to test the hypothesis: does adding a commercial head-tracking device to virtual desktop simulations improve military training effectiveness by providing a more intuitive user-input interface. The second experiment was designed to test the hypothesis: does adding a commercial game controller device to virtual desktop simulations improve military training effectiveness by providing a more intuitive user-input interface. In study one of our experimental design, we keep the keyboard or PS3 game controller consistent but change the head-tracking device. In the second study we keep the head tracker consistent and change the keyboard or game controller. This experimental design also controls for sequence of configuration seen by the participants (Table 7).

	Group	Input Device	Head Tracker		Input Device	Head Tracker
Study 1 (Head Tracker)	1	KB	–	→	KB	+
	2	KB	+	→	KB	–
	3	PS3	–	→	PS3	+
	4	PS3	+	→	PS3	–
Study 2 (Input Device)	5	PS3	+	→	KB	+
	6	KB	+	→	PS3	+
	7	PS3	–	→	KB	–
	8	KB	–	→	PS3	–

Table 7.   Experimental Design

As an exploratory hypothesis, we examined if factors, such as age and map representation, influence the effect of user input device on performance. It would be valuable to identify what type of Soldier could benefit most from different user input configurations or map representations. We also thought it would be useful to know if participants could predict their performance based on input device preference. This would give credence to the thought that one configuration is not superior to another, but superiority is based on the individual and not the configuration. The final recommendation might be to give the Soldiers ability to chose a configuration, for they will know what is best for them. The analysis was only conducted in the game controller study. Participants could not provide a head tracker preference since none were familiar with the new technology. Whereas, everyone was familiar with a game controller and 30 of the 33 participants had a preference between the game controller and the keyboard and mouse configuration.

2. Research Questions

1. Do user-input devices impact military training performance when used with a desktop virtual training simulation?

2. Do soldiers prefer one user-input device over another when using a desktop virtual training simulation?

3. Hypotheses

1. The addition of a commercial head-tracking device to virtual desktop simulations will improve performance in a virtual training simulation and be preferred over no head-tracking device.

2. The addition of a commercial game controller device to virtual desktop simulations will improve performance in a virtual training simulation and be preferred over the standard keyboard and mouse.

4. Exploratory Hypotheses

Do factors, such as age and map representation, influence the effect of user input device on performance and preference?

B. METHOD

1. Participants

We first approached the U.S. Army Battalion Commander at the Defense Language Institute six months prior to the experiment to formally brief and request his support. We explained the purpose and timeline of our study, logistical support requirements, requirements for his Soldiers, and how our study would benefit the U.S. Army. He agreed that our research was important and he would support our efforts. He then instructed his operations officer to contact his company commanders and ask for volunteers.

The participants for this study were all U.S. Army Soldiers enrolled in language training at the Defense Language Institute (DLI). They were all volunteers and were not provided any compensation. The Soldiers did have a requirement to perform a certain amount of community service. The unit chain of command determined that participation in our study warranted community service credit.

We had a total of 53 participants. All the participants were enlisted U.S. Army Soldiers ranging from Privates (E-1) to Staff Sergeants (E-6). The average age was 24.5 (5.2), with a range between 18 and 39. Six of the 53 participants were female.

Eighty-four percent (45 of 53) of the participants stated they had some type of computer gaming experience. Seventy-seven percent (41 of 53) stated they had console gaming experience with an average of 9.7 (8.4) years of experience. Seventy percent (37 of 53) stated they had PC gaming experience with an average of 7.7 (8.4) years of experience.

Thirty-four of the 53 (64 percent) identified themselves as 'gamers'. Based on discussion with pilot study participants we defined a "gamer" as anyone who spent more than 5 hours a week playing video games. Our pilot study participants believed that someone who played video games more than five hours a week would have a marked advantage in our study.

These levels of gaming experience are higher than you would typically find in the U.S. Army according to past studies. Roger Smith is the Chief Technology Officer for the U.S. Army Program Executive Office for Simulation, Training, and Instrumentation (PEO-STRI). Dr. Smith estimates about "50 percent of young enlisted Soldiers call themselves 'gamers' or are familiar with the mechanics of game play. At the officer level it is around 33 percent" (Atkinson-Bonasio, 2008). This difference was to be expected since the participants were self selected volunteers and 'gamers' are more likely to volunteer their time to play a video game for training.

Dr. Smith made this estimate 2 years ago and times are changing quickly. As time passes, it is not unreasonable to assume that more Soldiers are entering the military with gaming experiment while older soldiers without gaming experience retiring. The most likely of reason for this difference is our pool of participants were simply different then the U.S. Army as a whole. Our pool of participants consisted of linguist Soldiers attending language training at the Defense Language Institute (DLI). The Armed Services Vocational Attitude Battery (ASVAB) Skilled Technical (ST) test scores required to enlist as a linguist are much higher than the majority of military occupational specialties. Soldiers with higher ASVAB ST test scores are more likely to have access to computer based technologies.

2. Measures

a. Equipment

In the weeks prior to the DLI study we configured all the systems at NPS. This configuration included but was not limited to configuring the graphics, profile, scenario, batch, configuration, and Java jar files. We then installed and configured the NaturalPoint TrackIR5™ and SixAxis™ PS3™ interpreter software and drivers. The instruction for this procedure are listed in Appendix D. DLI Study Computer Setup.

Prior to the arrival of the participants, we prepared the 229th Military Intelligence Battalion conference room for our experiment. This preparation began with setting up and networking twenty Dell Precision M6300 laptops from a suite of the U.S. Marine Corps DVTE package. The computers were networked using D-LINK DGS-2208 port switches. Peripheral equipment, including mice, cables, and switches, came from the standard DVTE package. The user-input devices included Sony PS3™ game controllers and NaturalPoint TrackIR5™ head trackers.

All the computers were run in administrator mode with three software application running. The three software application were VBS2^{TM}, NaturalPoint TrackIR 5^{TM}, and the SixAxis^{TM} PS3^{TM} Interpreter. The VBS2^{TM} profile files were updated prior to each experimental group. The first profile file was the standard file but slightly modified by disabling some of the keyboard capabilities to ensure that the keyboard did not provide an advantage over the game controller. The second profile file, disabled all the keyboard functions to ensure that the participants were forced to use only the game controller and did not short cut the experiment by using keyboard commands. Lastly, we began the Java jar file to administer the survey and record the scoring data.

b.   Scenario

The evaluation course began with a mounted exercise where the participant drove a HUMMV and fired a crew served .50 Cal machine gun. This was followed by a dismounted exercise where the participant was required to negotiate several events and ended on a M4 rifle range (Figure 15). The participant started at the designated start point (1), drove through a serpentine course (2), and occupied the first vehicle battle position (3). There, the participant switched from the driver's seat to the gunner's station and engaged three truck targets. Afterward, the participant returned to the driver's seat and continued on the driving course. The participant negotiated a 90-degree left turn with buildings on both sides of the road (4). Additionally, two civilian vehicles approached in this area, and the participant had to negotiate around the oncoming traffic. Once through the built-up area, the participant occupies a second battle position (5), and engages three additional truck targets. Once the engagement is complete, the participant continued on the driving course, negotiating two more civilian vehicles worth of traffic. At the end of the mounted course (6), the participant combat parks the HUMMV by backing it between traffic barriers and cones. Measures of performance for the mounted exercise include the following: number of vehicle collisions with scenery objects including traffic,

number of times all four wheels of the vehicle went off the road, number of targets hit, number of rounds expended, and time for each portion of the course (Table 8).

Figure 15.   Evaluation Course Layout.

The dismounted portion of the course started when the participant entered the 'shoot / no shoot' event (7). This event was in a urban environment consisting of buildings and alleys where enemy and friendly targets were presented to the participants. The alleys were on opposite sides of the road, forcing the participant to look fully to the left and the right to determine which target to engage. The next event was the ramp and weave course (8) where participants walked across elevated ramps arranged at different angles. This was followed by two mazes. One maze had walls high enough that participants could not see over the top resulting in poor awareness of their surroundings or direction. The other maze had low walls so that participants can see over the top of the whole course. At the end of the second maze, the participants low crawled through a tunnel, stood, and ran to the individual shooting range (9). There,

participants engaged four near (<50 meters) and three distant (>200 meters) personnel targets. Performance measures for the individual portion include: number of falls off the ramps, number of enemy targets hit, number of friendly targets hit, number of rounds expended, and time for each portion of the course. Table 8 summarizes the full evaluation course.

Event	Participant Action	Performance Measure
Mounted weave	Drive around barricades as quickly as possible without wrecking the vehicle	• Time • Number of vehicle crashes
Mounted shooting range, Station 1	Use the HMMWV M2 to destroy 3 enemy trucks	• Time • Number targets hit • Number rounds expended
Mounted shooting range, Station 2	Use the HMMWV M2 to destroy 3 enemy trucks	• Time • Number targets hit • Number rounds expended
Mounted movement	Move from mounted movement course start to stop, with time at mounted shooting range stations subtracted	• Time • Number scenery objects hit • Number times vehicle off road
Ability to observe	Combat park vehicle Conduct shoot / no shoot alleys	• Time • Number targets hit • Number friendlies hit
Individual movement	Move through ramp weave, high weave, and low weave	• Time • Number falls off ramp
Individual shooting range	Use the rifle to shoot 6 short range personnel targets and 3 long range popup targets	• Time • Number targets hit • Number rounds expended

Table 8.   Interface evaluation course station guide

c.   Surveys

We used three surveys to gather demographic and preference data. The first survey was a pre-exercise survey designed to gather demographic data on the participants (Appendix G). The second was a post-exercise survey completed after the first run to gather initial participant preference data on the first configuration (Appendix H). The third survey was a post-exercise survey completed after the final run. It asked the same questions as the first post-exercise survey but added some additional questions focused on identifying participant preference between the two configurations (Appendix I).

3. Procedure

a. Arrival

When the participants arrived for the study they were sequestered into a separate room until all had arrived. The participants were asked two questions in order to insure the experimental groups were balanced. The first was "do you consider yourself a gamer?" We then defined a "gamer" as someone who plays video games more than 5 hours per week. The participants who identified themselves a gamers were then evenly distributed over each of the experimental groups.

The second question asked was if any of the self proclaimed "gamers" preferred inverted controls over standard controls. We felt that this was an important distinction that we learned from our pilot study and literature review. Only three of the 53 participants stated that they preferred inverted controls. We assigned these participants to VBS2™ systems configured with inverted controls. A third split was made on sex to ensure that men and women were evenly distributed over each control groups. We only had six women participants, so six experimental groups had one female and two groups had none.

b. Introduction Brief, Institutional Review Board (IRB) Consent Form, and Demographic Survey

The introduction brief explained purpose and generic details of the study (Figure 16). It was our intent to completely inform the participants of all details of the experiment. There was nothing to be gained by limiting their knowledge of the experiment. The participants were then instructed to read the internal review board (IRB) documentation and sign stating they were willing participants. The IRB consent form can be found in Appendix E. There were no balks at signing the IRB statement. After signing the IRB statement, the participants completed a demographic survey administered by the Java file. The demographic survey can be found in Appendix E.

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Figure 16.   DLI Study Introduction Brief

c.   *Conduct of the Exercise*

When everyone completed the demographic survey, we began the training session. The participants were provided a map and imagery representation of the training and test course (Appendix F). They were also provide a cheat sheet showing the keyboard and game controller commands and shortcuts (Appendix G). The training session consisted of an information briefing followed by a hands on exercise on how to move and shoot in the VBS2^{TM} virtual environment as an individual and mounted in military vehicle. Once each participant had successfully completed each training task, they were shown a video of a successful run on the evaluation course. Again, nothing was to be gained by the keeping any aspect of the test course a secret. This was an open book test where the limiting factor was the skill of the participant, not knowledge of the test. We also explained how their performance would be evaluated.

The participants were then instructed to complete the test course as quickly and accurately as possible (Figure 17). After the participants completed the test course, an automated trigger closed down VBS2^{TM} and opened a post exercise survey. This survey was designed to gain immediate feedback on their user-input device configuration. When they completed the post exercise survey they were put on a break. The breaks varied in time dependent on how quickly they finished the test but everyone was allowed at least ten minutes. During the break, we downloaded all demographic and post survey files, the automated scoring files, and the after action review video file. We also reconfigured the workstations user-input configurations for the second run.

Figure 17.   DLI Participants Testing on the PS3^{TM} Game Controller Configuration

Each participant returned to the same workstation and receive a second training session on a different user-input configuration. The participant completed the same test course using a different user-input configuration. Upon completion of the second test course, a trigger close the VBS2^{TM} application and opened a second post exercise survey. This survey asked the same questions

as the first post-exercise survey but added some additional questions focused on identifying participant preference between the two configurations.

C. RESULTS

1. Head Tracker Study Results

Paired t-test were used to test hypotheses regarding overall measure of performance and individual components of performance. The addition of the commercial head-tracking device to the virtual desktop simulation did not improve performance in a virtual training simulation and was not preferred over no head-tracking device. The participants' overall combined scores were significantly worse when using the head tracker (Table 9). The lower the score the better the performance.

- H_0: The addition of a commercial head-tracking device to virtual desktop simulations will not improve performance in a virtual training simulation and be preferred over no head-tracking device. ($\mu_d = 0$)

- H_a: The addition of a commercial head-tracking device to virtual desktop simulations will improve performance in a virtual training simulation and be preferred over no head-tracking device. ($\mu_d > 0$)

Head Tracker	Sample Size	Mean Score without HT (SD)	Mean Score with HT (SD)	t-test	p-value
Overall (Total)	22	17.43 (8.23)	22.18 (7.68)	-3.61	0.001

Table 9. Matched Paired T-test Comparing Overall (Total) Score with no Head Tracker (HT) to Scores with Head Tracker (Lower is better)

The participants scores did not improve with the head tracker on any event. The participants' scores on four of the six events were significantly worse when using the head tracker and the other two events were inconclusive (Table 10). The configuration without the head tracker demonstrated improved performance on the mounted moving, dismounted moving, dismounted shooting and the shoot house events. These events are highlighted in **yellow bold text** in Table 10. The mounted shooting and parking events were inconclusive. The

parking event was purposely designed to take advantage specific capabilities provided by of the head tracker and it also did not produce improved performance. The lower the score the better the performance.

Event	Sample Size	Mean Score without HT (SD)	Mean Score with HT (SD)	t-test	p-value
Mounted Moving	22	2.84 (0.94)	4.17 (2.27)	-3.44	0.001
Mounted Shooting	22	3.25 (2.51)	3.52 (2.23)	-0.45	0.328
Dismounted Moving	22	2.27 (2.02)	2.92 (1.97)	-1.75	0.047
Dismounted Shooting	22	1.93 (0.84)	2.84 (1.83)	-2.51	0.010
Shoot House	22	2.43 (1.76)	4.01 (1.91)	-3.85	0.001
Parking	22	4.69 (3.19)	4.69 (3.51)	0	0.500

Table 10.   Matched Paired T-test Comparing Scores with no Head Tracker between Scores with Head Tracker (Lower is better)
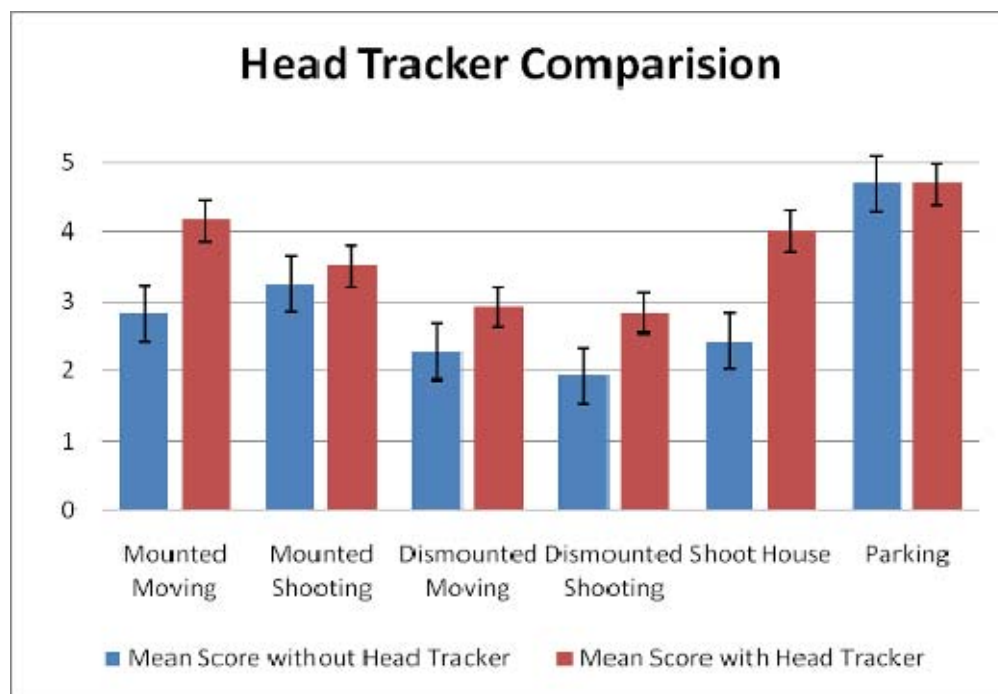
Figure 18.   Graph Comparing Mean Event Scores with no Head Tracker to Scores with Head Tracker (Lower is Better)

Finally, in the post survey, 11 of the 22 (50 percent) of the participants stated they preferred the addition of the head tracker. The other 11 participants stated they preferred no head-tracking device.

2.   Game Controller Study Results

Paired t-test were used to test hypotheses regarding overall measure of performance and individual components of performance. The addition of the commercial game controller to the virtual desktop simulation did not improve performance in a virtual training simulation and was not preferred over the keyboard and mouse configuration. The participants' overall combined scores were significantly worse when using the game controller (Table 11). The lower the score demonstrates the better the performance.

- H_0: The addition of a commercial game controller device to virtual desktop simulations will not improve performance in a virtual training simulation. ($\mu_d = 0$)

- H_a: The addition of a commercial game controller device to virtual desktop simulations will improve performance in a virtual training simulation. ($\mu_d > 0$)

Game Controller	Sample Size	Mean Keyboard Score (SD)	Mean Game Controller Score (SD)	t-test	p-value
Overall (Total)	31	11.27 (4.37)	14.13 (6.93)	-2.92	0.003

Table 11.   Matched Paired T-test Comparing Overall (Total) Game Controller to Scores with Keyboard and Mouse Configuration Scores (Lower is better)

The participants' scores on the separate events were mixed. The keyboard and mouse configuration demonstrated improved performance (events highlighted in **yellow bold text** in Table 12) on the mounted shooting, dismounted moving, and the shoot house events. The game controller configuration demonstrated improved performance (highlighted in *italicized green text* in Table 12) on the mounted moving and the parking events, both of these events involve driving a vehicle. The dismounted shooting event was inconclusive. The lower the score demonstrates the better the performance.

Event	Sample Size	Mean Keyboard Score (SD)	Mean Game Controller Score (SD)	t-test	p-value
Mounted Moving	31	3.51 (1.92)	2.98 (1.56)	1.73	0.046
Mounted Shooting	31	1.77 (1.27)	3.01 (2.37)	-2.62	0.007
Dismounted Moving	31	1.58 (1.09)	2.53 (1.96)	-2.89	0.004
Dismounted Shooting	31	2.61 (1.17)	2.98 (1.79)	-0.98	0.161
Shoot House	31	1.79 (1.15)	2.38 (1.71)	-2.06	0.023
Parking	31	3.61 (2.39)	2.83 (2.24)	1.71	0.048

Table 12.   Matched Paired T-test Comparing Game Controller Scores with Head Keyboard and Mouse Configuration Scores (Lower is better)

Finally, in the post survey 16 of the 31 (52 percent) of the participants stated they preferred the game controller configuration. The other 15 participants stated they preferred the keyboard and mouse configuration. When asked about what configuration they preferred while driving a vehicle 20 of the 31 (65 percent) of the participants stated they preferred the game controller.

3.   Exploratory Hypothesis Results

As an exploratory hypothesis, we examined if factors, such as age and map representation influence the effect of user input device on performance. It would be valuable to identify what type of Soldier could benefit most from different user input configurations or map representations.

We first examined if age was a useful contributor when modeling participant test performance. Young Solider have grown up in a culture where video games are pervasive. It would be interesting to see if younger Soldiers performed better with game controllers and head tracking device then older Soldiers.

- H$_0$: Age contributes nothing useful as a predictor of participant performance. ($\mu_d = 0$)

- H$_a$: Age makes a useful contribution to a model that predicts participant performance. ($\mu_d \neq 0$)

Study	Control	n	Intercept Estimate (SE)	Slope Estimate (SE)	R^2	F	p-value
Game Controller	Keyboard	31	12.13 (3.22)	-0.03 (0.13)	0.01	0.07	0.785
Game Controller	Game Controller	31	16.98 (5.08)	-0.12 (0.20)	0.01	0.33	0.567
Head Tracker	Head Tracker	22	14.66 (7.82)	0.33 (0.33)	0.04	0.96	0.337
Head Tracker	No Head Tracker	22	3.56 (7.98)	0.60 (0.33)	0.13	3.08	0.094

Table 13.   Inference for Linear Regression of age as a Useful Predictor for Participant Performance

The overall low R^2 and high p-values indicates age is a poor choice for building a model to predict participant performance. We do not reject our null hypothesis. We then decided to explore if gaming experience could contribute to a useful model to predict test performance. We used the following two questions in the demographic survey to measure participant gaming experience. 1. "How many years have you played PC video games on a regular basis?" and 2. "How many years have you played console video games on a regular basis?"   Regular basis was defined at least once a week.

- H_0: Gaming experience contributes nothing useful as a predictor of participant performance. ($\mu_d = 0$)

- H_a: Gaming experience makes a useful contribution to a model that predicts participant performance. ($\mu_d \neq 0$)

Study	Control	n	Intercept Estimate (SE)	Slope Estimate (SE)	R^2	F	p-value
Game Controller	Keyboard	31	13.90 (1.08)	-0.25 (0.08)	0.33	14.37	0.004
Game Controller	Game Controller	31	17.56 (1.80)	-0.32 (0.13)	0.17	6.11	0.019
Head Tracker	Head Tracker	22	21.19 (2.52)	-0.47 (0.24)	0.16	3.84	0.063
Head Tracker	No Head Tracker	22	27.92 (2.44)	-0.34 (0.23)	0.10	2.20	0.132

Table 14.   Inference for Linear Regression of Gaming Experience as a Useful Predictor for Participant Performance

The R^2 values range from 0.10 to 0.33 indicating that 10 percent to 33 percent of the variation in the participant test scores can be accounted for by the amount of participant's years of gaming experience. In the game controller study, our p-values are less than our 0.05 alpha.   We reject our null hypothesis (H_0) in favor of our alternate hypothesis (H_a). Based on the regression model, for every additional year of gaming experience, we predict an improvement of 0.25 in performance on a normalized ten point scoring system when using the keyboard configuration. We would predict an improvement of 0.32 when using the game controller.   The negative slope indicates an improvement in performance as gaming experience increased because in our study a lower score is better. Therefore, gaming experience makes a useful contribution to a model predicting participant performance. In the head tracker study, gaming experience p-values are much lower than the previous age p-values but still are not within our alpha of 0.05.

Finally, we wanted to examine if other factors such as sex and input device preference as possible predictors for test performance. We found that males performed much better than female participants. In the game controller study, the males mean overall score was 13.2 (6.2) when using the game controller and 11.0 (4.4) when using the keyboard. The female mean overall

score was 27.4 (0.3) when using the game controller and 15.3 (1.7) when using the keyboard. In the head tracker study, the males mean overall score was 21.7 (8.0) when using the head tracker and 16.6 (7.7) when not using the head tracker. The female mean overall score was 25.3 (4.9) when using the head tracker and 22.5 (11.44) when not using the head tracker. We only had six female participants out of our 53 total participants, so due to our small sample size, we could not rely on sex as a useful predictor.

We then wanted to examine if input device preference would make a useful contribution to modeling participant performance.

- H_0: Participant input device preference contributes nothing useful as a predictor of participant performance. ($\mu_d = 0$)

- H_a: Participant input device preference makes a useful contribution to a model that predicts participant performance. ($\mu_d \neq 0$)

Test Score when using	n	Intercept Estimate (SE)	Slope Estimate (SE)	R^2	F	p-value
Game Controller	31	1.30 (3.00)	2.41 (0.53)	0.41	4.53	<0.001
Keyboard and Mouse	31	4.14 (2.03)	1.33 (0.36)	0.32	3.70	<0.001

Table 15. Inference for linear regression of participant input device preference as a useful predictor for participant performance
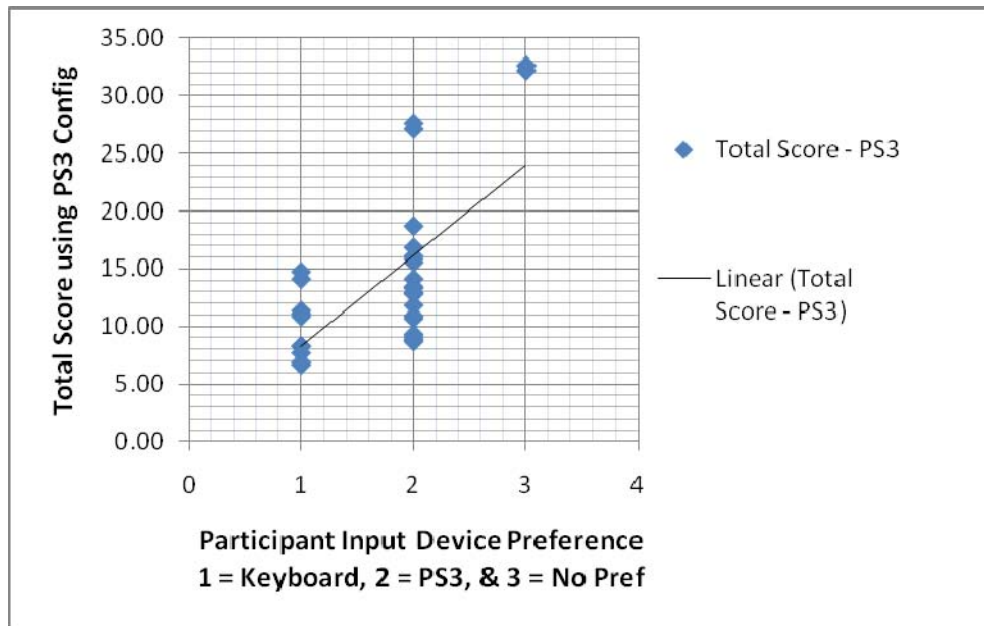
Figure 19. Graph depicting participant total scores by input device preference when using the game controller configuration. (lower scores are better)
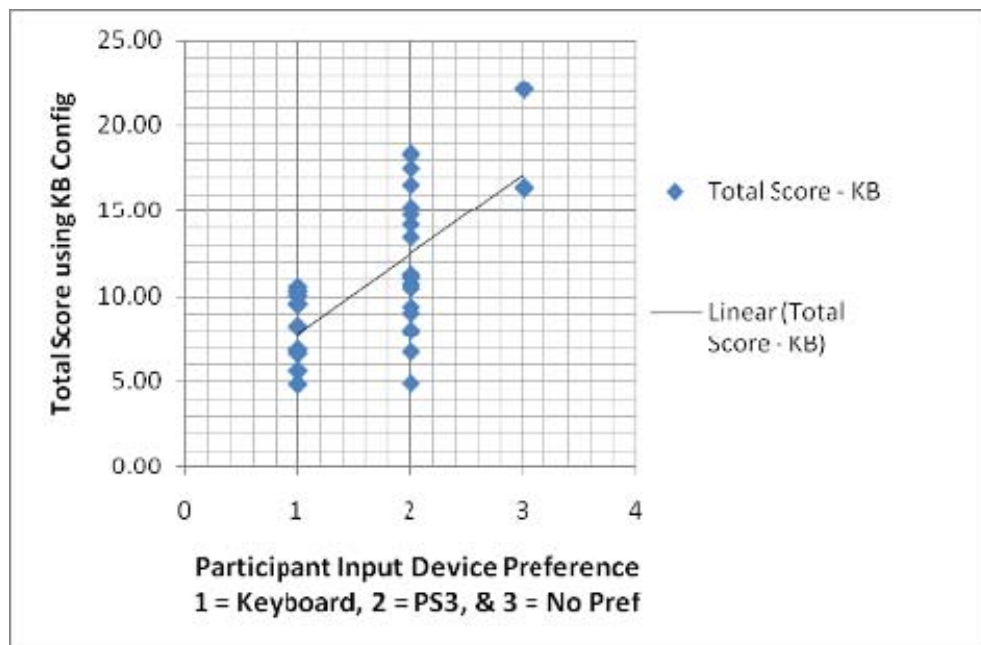
Figure 20. Graph depicting participant total scores by input device preference when using the keyboard and mouse configuration. (lower scores are better)

The R-square values of 0.32 to 0.41 indicating that 32 percent to 41 percentof the variation in the participant test scores can be accounted for by the participant's input device preference.   In both configurations of our game controller study, our p-values are less than our 0.05 alpha. We were tempted to reject our null hypothesis (H_0) in favor of our alternate hypothesis (Ha) but thought there was a possibility that the poor performance by the two participants who stated they had no user input device preference could be driving our analysis. Their poor performance coupled with their small sample size of two lead us to recalculate our results without the participants who had no user input device preference.

Test Score when using	n	Intercept Estimate (SE)	Slope Estimate (SE)	R^2	F	p-value
Game Controller	29	5.57 (3.17)	4.41 (1.84)	0.18	5.73	0.024
Keyboard and Mouse	29	4.39 (2.33)	3.83 (1.36)	0.23	7.94	0.008

Table 16.   Linear regression analysis without participants scores who had no user input device preference
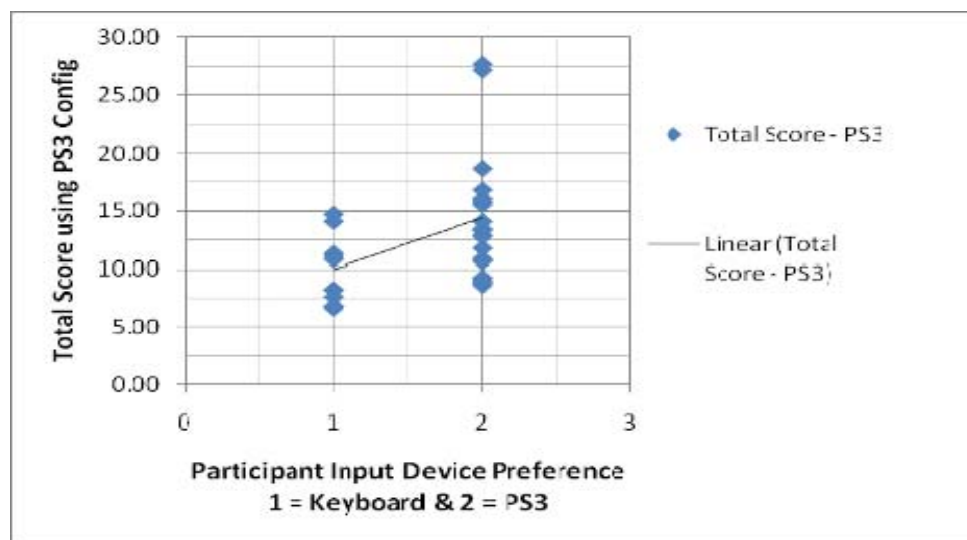
Figure 21.   Graph depicting participant total scores by input device preference without participants scores who had no user input device preference.
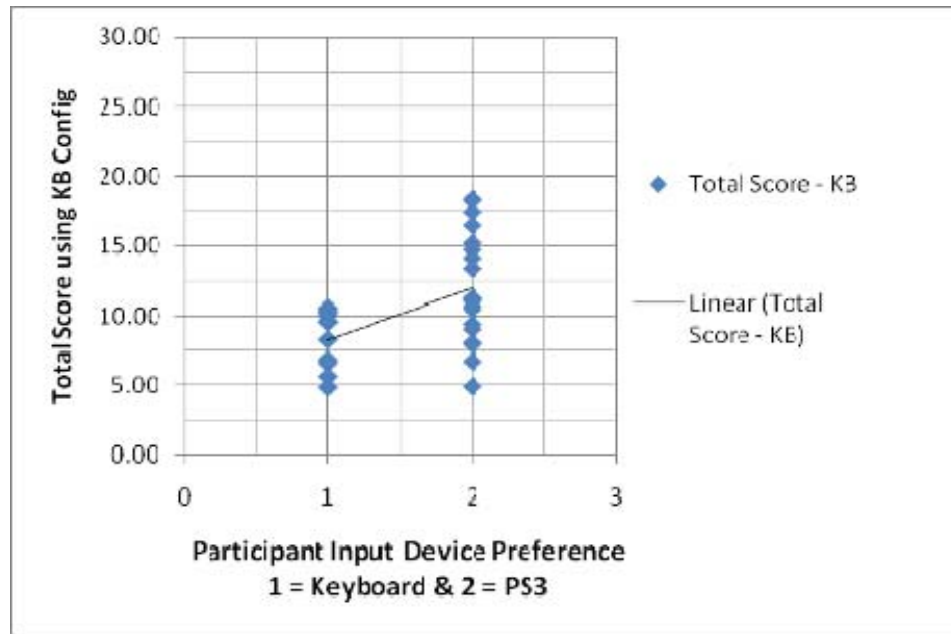
Figure 22.   Graph depicting participant total scores by input device preference without participants scores who had no user input device preference.

The R-square values of 0.18 to 0.23 were lower than our first calculations but our p-values were still less than our 0.05 alpha. Again, we were tempted to reject our null hypothesis (H_0) in favor of our alternate hypothesis (H_a) but we then thought the two possible outliers in Figure 21 could skewing our analysis. They were not three standard deviations from the mean but recalculate our game controller results for completeness.

Test Score when using	n	Intercept Estimate (SE)	Slope Estimate (SE)	R^2	F	p-value
Game Controller	27	7.09 (2.02)	2.88 (1.19)	0.19	5.85	0.023

Table 17.   Linear regression analysis without two possible outliers.
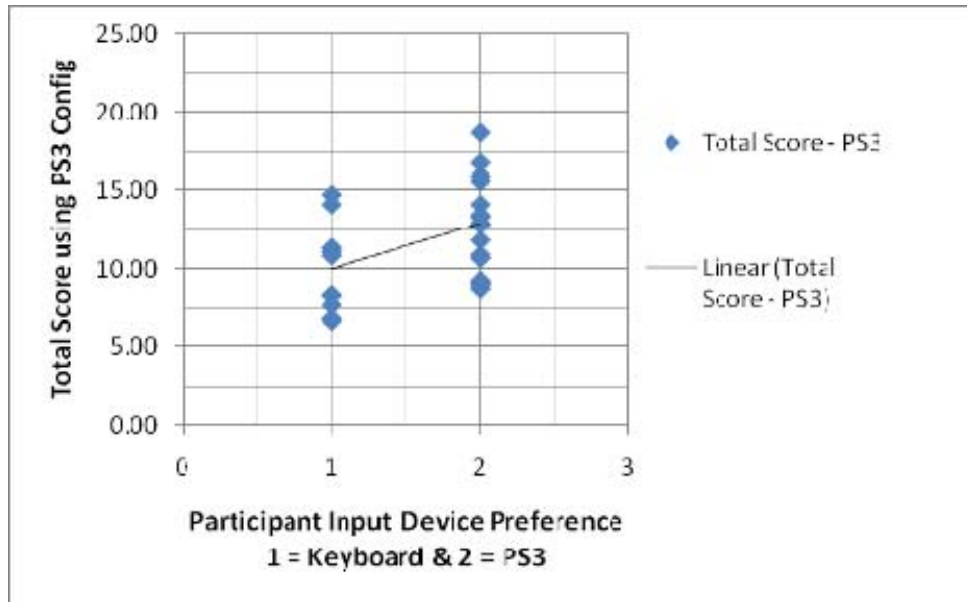
Figure 23.   Graph depicting participant total scores by input device
preference without two possible outliers.

This last iteration had R-square values of 0.19 to 0.23 indicating that 19 percent to 23 percent of the variation in the participant test scores can be accounted for by the participant's input device preference. Our p-values continued to be less than our 0.05 alpha. We reject our null hypothesis (H_0) in favor of our alternate hypothesis (H_a). Participant input device preference makes a useful contribution to a model predicting participant performance. The participants that stated they preferred using a keyboard and mouse over a game controller performed better on both configurations. The participants who stated they had no preference performed the worst.

The last factor we examined was map representations. Each participant was provided a map and imagery representation of the training and test courses (See Figures 24 and 25). They were also told they could use either of the two representations and would be asked for their preference in the post survey.
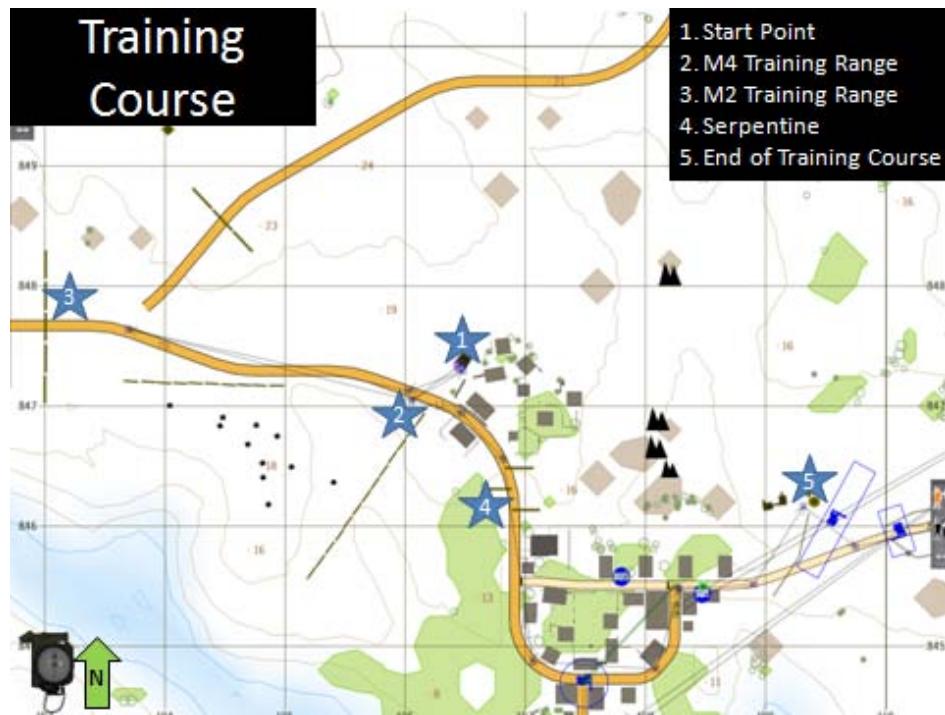
Figure 24.   Map Representation of Training Course

Figure 25.   Imagery Representation of Training Course

In the post survey, 39 of 53 (75.5 percent) participants responded that they preferred using the imagery representation over the traditional map representation when navigating the training and test courses.

VI. RECOMMENDATION AND CONCLUSIONS

A. OVERVIEW

Personal computer and console gaming technology has advanced to the point where virtual desktop trainers have become ubiquitous to the U.S. military. Virtual desktop trainers have the capability of altering the interface by adding game controllers, larger screens, head mounted displays, head-tracking devices, and improved communication interfaces. The military will gladly pay for additional peripheral devices but only if they can demonstrate an improvement on training effectiveness.

The purpose of this thesis was to provide a recommendation and a reference to decision makers when configuring virtual desktop trainer peripheral interface devices. We defined the problem as: "When using a virtual desktop simulation for training, do commercial head-tracking and video game controller devices improve training effectiveness by providing a more intuitive user interface?"

B. RESEARCH QUESTIONS

1. Do user-input devices impact military training performance when used with a desktop virtual training simulation?

2. Do soldiers prefer one user-input device over another when using a desktop virtual training simulation?

C. OVERALL ASSESSMENT

Our overall assessment of study is very positive. The significant time and effort in preparing, executing, and analyzing the pilot study, enable us to employ a final within subjects experiment capable of producing quality data. We have the upmost confidence in our data and our analysis. We found that the keyboard and mouse was superior to the game controller configuration in overall performance. The one exception was during the driving event where the game

controller was superior. The head tracker was found to be detrimental to overall performance. When training with desktop virtual simulations, we recommend a user input configuration consisting of the keyboard and mouse without the head tracker as a baseline configuration. We also recommend implementing game controllers as an additional input device for units training tasks that require trainees to drive vehicles. We believe this configuration provides a more intuitive user interface that minimizes the initial training time required to teach users to perform basic individual, weapon, and vehicle functions in a virtual desktop simulator. This time savings should result in more time available to train the skills that will keep a soldier alive in combat instead to learning how to interact with the simulation.

D. DISCUSSION OF RESULTS

1. Head Tracker Study

Contrary to our hypothesis, use of the head tracker did not improve overall performance. Based on this result, we were surprised that 50 percent of participants reported a favorable head tracker preference. When participants donned the TrackIR5^{TM} baseball caps and first used the head tracker, the excitement was obvious. Initial comments ranged from "cool," "awesome," to "greatest thing ever." At the end of the experiment, participants were less excited but mostly voiced their support of the head tracker. In retrospect, we believe the participants continued to voice their support of the head tracker at the end of the experiment because they believed it was what we wanted to hear.

We assumed in the formulation of our hypothesis, at worst, the head tracker would have no effect on performance. This was wrong. We actually found that the head tracker had an adverse effect on overall performance. Additionally, the head tracker had an adverse effect on four of the six events and was inconclusive on the other two events. Despite this adverse affect on performance, 50 percent of the participants stated they preferred the addition of the head tracker.

The inability of the head tracker to improve performance was not a surprise. We were surprised when we found the head tracker actually had an adverse effect on performance. The head tracker does provide an additional amount of control to the participant. This additional amount of control is small and comes at a cost. This cost comes in the complexity of an additional input device. A participant with more advanced gaming skills might appreciate and exploit the additional control but most found it overwhelming. When participants inadvertently move the head tracker, they unknowingly changed the player perspective in the virtual world. At first, most participants were using the head tracker but by the end of the test, most participants kept their head as still as possible. Keeping their heads locked in one position essentially disabled the head tracker. This limited their ability to view the surrounding area but kept their viewing perspective consistent. By keeping their view perspective consistent, the participant improved their ability to control their player and limited the possibly of disorientation and getting lost in the virtual environment.

The 50 percent of participants who stated they preferred the head tracker despite performing better without the head tracker was surprising. Four of the twenty-two participants actually performed better with the head tracker and it is logical they would prefer the head tracker configuration. The inconsistency lies with the seven participants who performed poorly with the head tracker but stated they preferred it. We believe the reason for this inconsistency is a combination of the newness of the technology and limiting participants to only 20 minutes of training prior to testing. It is possible these seven participants saw the potential of this technology and believed if they were given more time using the head tracker they would have performed better. The participants may have been sending us a message that more time was needed to attain an acceptable level of proficiency using the head tracker. Conversely, these results indicate that subjective preference may not be a good indicator of actual performance.

2.   Game Controller Study

Our literature review indicated that people had strong opinions about game controllers, but the opinions were based on personal preference and not reason. The pilot study results demonstrated an improved performance with the game controller but we believed that sequence was the determining factor—not input device. In the pilot study, all participants tested with the keyboard and mouse configuration first and then the game controller second. This learning effect was considered in our experimental design and balanced within our final study.

After participants completed the DLI experiment, we conducted verbal exit polling that provided no insights on potential results. Participant comments equally praised and disparaged both configurations. This made the data analysis that much more exciting because we truly did not know what to expect.

Contrary to our hypothesis, use of the game controller did not improve overall performance and the keyboard and mouse configuration was superior. Based on this result, we were surprised that 52 percent of participants reported a favorable game controller preference. The keyboard and mouse was superior in three of the six events, the game controller was superior in two events, and one event was inconclusive. The game controller was superior in the two driving events.

The keyboard and mouse outperformed the game controller in the mounted shooting, dismounted moving, and shoot house events. We believe the reason for this has less to do with the keyboard and more to do with the mouse. The mouse is designed for micro movements. The limiting factor in the shooting events is the exact placement of the reticule on the target or positioning of the player. When using the mouse to sight a weapons or position a player, the participant uses his forearm, wrist, and fingers to move the mouse to the desired location. When using the game controller, only the thumb is used to sight the weapon or position the player. The additional number of muscles used with the

mouse increases the participant's ability to precisely control the weapon or player. Therefore, when precision is required, the keyboard and mouse proved superior to the game controller.

The game controller outperformed the keyboard and mouse in the two driving events. In these events, precision was not the key factor in performance. We believe the motivating factor was simplicity. When using the keyboard and mouse to drive the vehicle, the participant used the W key to move forward and the A and D keys to move left and right, respectively. When the participant pressed the A key the vehicle made a full 90 degree turn and when they released the key, the steering wheel returned to the center position. This resulted in an all or nothing effect. If the participant wanted to turn 45 degrees, then they would have to alternate pressing the A and the W keys back and forth. When using the game controller, the participants simply move the thumb stick in the direction of the turn and the vehicle responded. The mouse could also be used to turn the vehicle but also proved to be very difficult to control. The vehicle would turn as long as the mouse was moving to the left or the right, but when the mouse ran off the mouse pad, the table, or beyond the reach of the participant the steering wheel would return to the center position.

The game controller was also superior in controlling the speed of the vehicle. When the participant pressed the W key to move forward the HUMMV accelerated to top speed and rolled to a stop when released. Again, it was an all or nothing. This resulted in participants tapping on the W key to correspond with how fast they wanted to move. When the participant used the game controller and wanted to go slow, they would slightly move the thumb controller forward and the vehicle would respond. If they wanted to increase the speed, they increased pressure on the thumb control. The simplicity of the game controller over the keyboard and mouse was the determining factor in the driving events.

We were surprised when 52 percent of participants stated they preferred the game controller despite performing testing indicated the keyboard and mouse was the superior configuration. Nine of the thirty-one participants actually

performed better with the game controller and it is logical they would prefer the game controller configuration. The inconsistency lies with the seven participants who performed poorly with the game controller but stated they preferred it. We believe the reason for this inconsistency is the perception between personal computers and console game systems. The prevailing perception is personal computers are for work and console game systems are for play. We believe this perception between work and play is what lead to the majority of participants stating they preferred the game controller despite performing better with the keyboard and mouse configuration.

3. Exploratory Hypothesis Results

Contrary to our hypothesis, age was not a useful contributor when modeling participant test performance. Young soldiers have grown up in a culture where video games are pervasive and we thought this would provide them an advantage over older Soldiers. Our data did not support this hypothesis. Alternatively, the age range in our sample was not large enough to capture age differences. Next, we tested a second exploratory hypothesis to find out whether gaming experience would contribute to a useful model to predict test performance. We found that gaming experience in fact did contribute to a useful model to predict performance. These findings are logical. A Soldier's youth does not automatically translate to video game skills, but years of gaming experience, regardless of age, does translate to superior performance.

We then tested a third hypothesis to find out whether participant input device preferences make a useful contribution to a model that predicts participant performance. Consistent with our hypothesis, input device preference did predict performance. We originally thought that participants would be able to predict what input device they would perform best with, but they did not. We found that participants who preferred the keyboard and mouse configuration performed better on both user input configurations. Those who preferred the game controllers had worse performance scores. We believe this reinforces our

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findings that the keyboard and mouse is a superior input device. The participants who achieved the best performance scores were also those with several years of gaming experience and presumably knew before the experiment that the keyboard and mouse was a superior input device. These participants did not need the results of a study to tell them that the keyboard and mouse was superior to the game controller. They had years of gaming experience, playing all types of video games, to tell them the keyboard and mouse was superior. This may call into question why did we conduct an experiment instead of a survey. The challenge in conducting such a survey would be who do you poll? We only found out who the experts were after the experiment. Prior to the experiment, everyone just had opinions but after the experiment we could identify who the experts were by their superior performance scores. When we looked at the experts input device preference they were over overwhelming in support of the keyboard and mouse configuration. We believe this provides further support to our findings that the keyboard and mouse is a superior user input device when training with desktop virtual simulations.

The last factor we examined was map representations. In the post survey, 75.5 percent of participants responded that they preferred using the imagery representation over the traditional map representation when navigating the training and test courses. We thought there may be a relationship between age and map representation. We hypothesized that younger Soldiers would prefer imagery and older soldiers would prefer traditional maps. We could not support this hypothesis and found most soldiers preferred the imagery regardless of age. We believe this finding was the result of the additional information provided by imagery. Both the imagery and traditional map provided sufficient information to navigate the course. The imagery simply provided more information to the participant. One example is the traditional map simply provided the location of a building and all of the buildings looked the same. The imagery provided the location, color, and the relative height of the buildings. Furthermore, the maps representation of terrain elevation and vegetation was very poor as compared to

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what the detail provided by the imagery. Lastly, the map did not represent details such as highway signs that were clearly represented in the imagery. All of this additional information resulted in the imagery being favored over the traditional maps.

E.   LIMITATIONS

1.   Time

The biggest limitation in our experiment was time. Specifically, the time participants were allowed to train on the user input device prior to testing. We limited this training time to 20 minutes. Our results could have been far different if we had doubled or tripled the training time.

2.   Training Task

We investigated the effects of head trackers and game controllers on essentially four training task. These tasks were driving a HUMMV, shooting a .50 Cal machinegun, dismounted movement, and shooting a M4 rifle. The number of task VBS2^{TM} can train is only limited by the imagination of the trainer. It would be interesting to see our study expanded into different training task such as tank crew, aviation crew, call for fire, and reconnaissance tasks.

3.   Sample Population

The participants for this study were all U.S. Army operational support Soldiers enrolled in language training at the Defense Language Institute (DLI). There is a important difference between combat arms Soldiers and a operational support Soldiers. Our participant population was chosen because they were young Soldiers but limited because they were all operational support Soldiers and no combat arms Soldiers were included due to availability.

A second sample population limitation was the number of females participants. We found that males performed much better than female participants on each configuration. We only had six female participants out of

our 53 total participants. This small sample size limited our ability to find statistical significance within our female sample population.

F. RECOMMENDATIONS

1. Configuration Recommendations

When training with desktop virtual simulations, we recommend a user input configuration consisting of the keyboard and mouse without the head tracker as a baseline. We also recommend game controllers as an additional input device for when units are training tasks that require trainees to drive vehicles. For example, if a unit is training HUMMV convoy operations with a traditional 4 man vehicle crew, we would recommend all four crew members have the baseline configuration with the addition of one game controller for the vehicle driver.

2. Recommendation for Future Work

a. *Testing of Other User Input Devices*

We only tested two different user input devices. Virtual desktop trainers have the capability of altering the interface by adding various game controllers, steering wheels, and improved communication interfaces. Investigating the any of these user input devices could result in improved training effectiveness would be a worthy endeavor.

b. *Testing of Different Visual Displays*

We conducted our test using the standard laptop screen provided by the DVTE suite. It would be valuable to find out what visual deliver system best creates the immersive effect and how much field of view does it require. The controls of interest are laptop screens, larger monitors, wall sized project screen, panoramic displays, and head mounted displays.

c.   *Integrating Physical Active With Virtual Training*

Our participants sat in front of a laptop computer as they drove, ran, and shot their way through a challenging evaluation course.   How would integrating a virtual sphere, carrying a wireless rifle, and wearing a head mounted display impact training effectiveness when used in conjunction with a desktop virtual simulation such as VBS2^{TM}.

d.   *Change Sample Population*

The participants for this study were all U.S. Army operational support Soldiers enrolled in language training at the Defense Language Institute (DLI). There is a significant difference between a combat arms Soldier and a operational support soldiers. How would combat arms Soldiers' performance compare to operational support Soldiers performance in the same test.

We only had six female participants out of our 53 total participants. This small sample size limited our ability to find statistical significance within our female sample population. It would be valuable to know if there is a gender difference when training with desktop virtual simulations.

APPENDIX A. PILOT STUDY COMPUTER SET UP

1) Unload VBS2 Boxes
   - Each individual: Laptop, power cords, mouse, and LAN Cable
   - Each row: Switch, LAN Cable, and Surge suppressor

2) Start Brief
   - Intro
   - Agenda
   - Background
   - Paperwork

3) Read and sign IRB Consent

4) Collect IRB Consent

5) Turn On

6) Login
   - Ctrl-Alt-Del x 2
   - User Name: administrator
   - Password: DVTEM90build2
   - OK

7) Set Time on Clock

8) Access Shared Folder on "DVTE30"
   - Right Click "Start"
   - Explore
   - Scroll to the bottom and open "My network places/Entire Network/Microsoft Windows Network/MShome/DVTE30
   - Click to open SharedDocs Folder
   - Copy and paste "Pilot Study Download" folder into your "Administrator/My Documents" folder

9) Profile
   - Open "Pilot Study Download\VBS2 input profiles"
   - Copy "AdministratorKBNew.VBSProfile" (file)
   - Paste in C:\Documents and Settings\administrator\My Documents\VBS2
   - Rename current "Administrator.VBSProfile" to "AdministratorOld.VBSProfile"

- Rename "Administrator KBNew.VBSProfile" to "Administrator.VBS2Profile"

10) Interface Scenario
- Open "Pilot Study Download"
- Copy "InterfaceTrainerPilot.Sara" folder
- Paste in C:\Documents and Settings\administrator\My Documents\VBS2\MPMissions

11) Interface Lib-Interface Data
- Open "Pilot Study Download"
- Copy "InterfaceLib" folder
- Paste in C:\Program Files\Bohemia Interactive\VBS2 VTK\   (New place)
- Open "Pilot Study Download\Jar files"
- Copy the "InterfaceData##" file that corresponds with your VBS2 laptop number (113-   DVTE - ##)
- Paste in C:\Program Files\Bohemia Interactive\VBS2 VTK\InterfaceLib

12) Interface batch file
- Open "Pilot Study Download\InterfaceDataCollectorBat"
- Copy the "InterfaceDataCollector##" file that corresponds with your VBS2 laptop number   (113 - DVTE - ##)
- Paste in C:\Program Files\Bohemia Interactive\VBS2 VTK\

13) disEntity and VBSEntity Config files
- Open "Pilot Study Download\"
- Copy "disEntity.config" and "vbsEntity.config" files
- Paste in C:\Program Files\Bohemia Interactive\VBS2 VTK\config
- Answer yes to all "overwrite"

14) Modify DIS Deploy file.
- Open C:\Program Files\Bohemia Interactive\VBS2 VTK\config
- Right click on the "dis.deploy" file
- Left click on "edit"
- The 7th line reads "<broadcastAddress>10.1.10.###</broadcastAddress>"
- Change line to read "<broadcastAddress>10.1.10.255</broadcastAddress>"
- The 8th line reads "<broadcastPort>10000</broadcastPort>
- Change line to read "<broadcastPort>100##</broadcastPort>," where ## is your VBS2 laptop number
- Save file with same name
- Close file

15) PS3 Controller and Headtracker driver
- Open "Pilot Study Download\Drivers"
- Double click on the TrackIR_4.1.037.Final -
- Follow instructions -
  - Ok
  - Next
  - Yes
  - Next
  - Next
  - Next
  - Next
  - No (when asked to scan for old INF files)
  - Finish

- Open "Pilot Study Download\Drivers" and Double click on "wrar390"
- Install
- When asked to associate with? chose "RAR"
- Click "Done"
- Close win War Screen
- Open "Pilot Study Download\Drivers"
- Double click on 1167_Sixaxis_PS3_Win32
- Click close
- Click on "Extract to"
- On right hand side chose to extract to desktop
- Close window
- Create a folder on desktop called PS3
- Move the three new file into the folder called PS3
  - (libusb-win, libusb0.dll, and ps3sixaxis)

16) Emergency post survey
- Create folder on desktop called "Emergency Post Survey"
- Open "Pilot Study Download\Jar Files"
- Copy "EmergegcyPostSurvey_9999
- Paste in desktop\ Emergency Post Survey

17) Shortcuts
- Open " C:\Program Files\Bohemia Interactive\VBS2 VTK"
- Right click on "VBS2 LVC Game"
- Hover over "Send to"
- Select "Desktop (create shortcut)"
- Right click on "InterfaceDataCollector##"
- Hover over "Send to"
- Select "Desktop Create shortcut)"

- Rename the short cut by removing the "Shortcut to"

18) Right click the desktop and arrange icons by type.

19) Check your work
- Double click on "VBS2 LVC Game" Short Cut - Wait awhile
- Click on networking
- Click on new
- Click on Sahrani
- Click on InterfaceTrainerPilot
- Click on OK
- Click on Marine (bottom left)
- Click on OK
- Wait
- Click continue
- After the scenario loads press "ALT & Tab"
- Double click InterfaceDataCollector## Shortcut
- Enter 0001 as your participant number
- Complete the survey and wait for 4-5 seconds
- Your DOS window should then read
  "All trigger catalogued"
  "All targets catalogued"

  If your window provides this message then you get a "A" for this lesson.
  If not, additional instruction will be provided this Saturday at 1200.

20) Control-C
21) Yes and enter
22) Click on VBS2
23) Escape
24) Abort
25) OK
26) Escape
27) Cancel
28) Cancel
29) Cancel
30) Big red X
31) Close windows explorer

APPENDIX B. PILOT STUDY INFORMED CONSENT

Informed Consent Form

Introduction. You are invited to participate in a research study entitled "Impact of User Interfaces on Virtual Battlespace 2 Training Pilot Study." This study supports a project to compare different user-input interfaces and visual peripherals devices when conducting military training using VBS2^{TM}.

This pilot study tests procedures to familiarize users with the simulation.

Procedures. The pilot study will consist of the following:
- Survey to better understand the user's level of computer expertise;
- Overview brief describing the project and the pilot study's purpose;
- User interface brief describing the basic functions of the simulation;
- User training, where participants will be able to move dismount and drive a HUMMV. The participants will also engage targets with personnel weapons and mounted crew served weapons in the VBS2^{TM} simulation;
- User evaluation, where participants will complete a short obstacle course demonstrating their skill level with the simulation.

The pilot study will take no longer than the 50 minute class period.

Risks. The potential risks of participating in this study are not greater than minimal risk. The study involves no known reasonably foreseeable risks or hazards greater than those encountered in everyday life.

Benefits. The anticipated benefit from this study is gaining insight into how to best configure first person shooter simulations when using them as tactical training devices.

Compensation. No tangible compensation will be given. A copy of the research results will be available at the conclusion of the experiment. If you would like a copy of the results, e-mail Major William Glaser at wrglaser@nps.edu.

Confidentiality & Privacy Act. Any information that is obtained during this study will be kept confidential to the full extent permitted by law. All efforts, within

reason, will be made to keep your personal information in your research record confidential but total confidentiality cannot be guaranteed. No information that could identify a participant will be publicly accessible. Records of participation will be maintained by NPS for 3 years, after which they will be destroyed. However, it is possible that the researcher may be required to divulge information obtained in the course of this research to the subject's chain of command or other legal body.

Voluntary Nature of the Study. Participation in this study is strictly voluntary, and if agreement to participation is given, it can be withdrawn at any time without prejudice.

Points of Contact. It is understood that should any questions or comments arise regarding this project, or a research related injury is received, the Principal Investigator, Dr. William J. Becker, 656-3963, wjbecker@nps.edu should be contacted. Any other questions or concerns may be addressed to the Navy Postgraduate School. IRB Chair, LCDR Paul O'Connor , 831-656-3864, peoconno@nps.edu.

Statement of Consent. I have read the information provided above. I have been given the opportunity to ask questions and all the questions have been answered to my satisfaction. I have been provided a copy of this form for my records and I agree to participate in this study. I understand that by agreeing to participate in this research and signing this form, I do not waive any of my legal rights.

_____   _____
Participant's Signature   Date

_____   _____
Researcher's Signature   Date

WILLIAM R. GLASER
MAJ, AR (FA57)
NPS MOVES Student

APPENDIX C. PILOT STUDY APPROVED IRB PROTOCOL
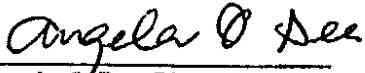
Naval Postgraduate School
Institutional Review Board (IRB)

From: President, Naval Postgraduate School   **JAN 2 5 2010**
Via: Chairman, Institutional Review Board
To: William Becker, MOVES Institute
          William Glaser

Subject: PROJECT STATUS: IMPACT OF USER INTERFACES ON VIRTUAL
          BATTLESPACE 2 TRAINING PILOT STUDY

1. The NPS IRB is pleased to inform you that the NPS Institutional Review
    Board has approved your project (NPS IRB# NPS.2010.0023-IR-EP7-A).
    Completion of the CITI Research Ethics Training has been confirmed.

2. This approval is valid until 1 August 10. Please submit all reporting
    requirements to the Human Subjects Office (Rikki Panis, Halligan Hall,
    Room 283) at the conclusion of this project.

3. If your protocol changes at any time, you will need to resubmit your
    project proposal to the NPS IRB.

4. As the Principal Investigator it is your responsibility to ensure that the
    research and the actions of all project personnel involved in conducting
    this study will conform with the IRB approved protocol and IRB
    requirements/policies.

5. After the experiment is completed the Principal Investigator will submit to
    the Human Subjects Research Office, all signed informed consent
    documents, unanticipated problem reports, adverse event reports and a
    final report. The Human Subjects Research Office will secure these
    documents for three (3) years and then destroy, as prescribed by law.

Angela O'Dea PhD   Daniel T. Oliver
Chair   President
Institutional Review Board   Naval Postgraduate School

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APPENDIX D. DLI STUDY COMPUTER SET UP

1) Turn computer on

2) Login
   - Ctrl-Alt-Del x 2
   - User Name: administrator
   - Password: DVTEM90build2
   - OK

3) Access Shared Folder on "DVTE30"
   - Right Click "Start"
   - Explore
   - Scroll to the bottom and open "My network places/Entire Network/Microsoft Windows Network/MShome/DVTE30
   - Click to open SharedDocs Folder
   - Copy and paste "Pilot Study Download" folder into your "Administrator/My Documents" folder

4) Profile
   - Open "Pilot Study Download\VBS2 input profiles"
   - Copy "AdministratorKBNew.VBSProfile" (file)
   - Paste in C:\Documents and Settings\administrator\My Documents\VBS2
   - Rename current "Administrator.VBSProfile" to "AdministratorOld.VBSProfile"
   - Rename "Administrator KBNew.VBSProfile" to "Administrator.VBS2Profile"

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6) Interface Lib-Interface Data
   - Open "Pilot Study Download"
   - Copy "InterfaceLib" folder
   - Paste in C:\Program Files\Bohemia Interactive\VBS2 VTK\   (New place)
   - Open "Pilot Study Download\Jar files"
   - Copy the "InterfaceData##" file that corresponds with your VBS2 laptop number (113-   DVTE - ##)
   - Paste in C:\Program Files\Bohemia Interactive\VBS2 VTK\InterfaceLib

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- Open "Pilot Study Download\"
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- Answer yes to all "overwrite"

9) Modify DIS Deploy file.
- Open C:\Program Files\Bohemia Interactive\VBS2 VTK\config
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- Left click on "edit"
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- Change line to read "<broadcastAddress>10.1.10.255</broadcastAddress>"
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- Change line to read "<broadcastPort>100##</broadcastPort>," where ## is your VBS2 laptop number
- Save file with same name
- Close file

10) PS3 Controller and Headtracker driver
- Open "Pilot Study Download\Drivers"
- Double click on the TrackIR_4.1.037.Final -
- Follow instructions -
  - (a) Ok
  - (b) Next
  - (c) Yes
  - (d) Next
  - (e) Next
  - (f) Next
  - (g) Next
  - (h) No (when asked to scan for old INF files)
  - (i) Finish

- Open "Pilot Study Download\Drivers" and Double click on "wrar390"
- Install
- When asked to associate with? chose "RAR"
- Click "Done"
- Close win War Screen
- Open "Pilot Study Download\Drivers"

- Double click on 1167_Sixaxis_PS3_Win32
- Click close
- Click on "Extract to"
- On right hand side chose to extract to desktop
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- Create a folder on desktop called PS3
- Move the three new file into the folder called PS3 (libusb-win, libusb0.dll, and ps3sixaxis)

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- Right click on "VBS2 LVC Game"
- Hover over "Send to"
- Select "Desktop (create shortcut)"
- Right click on "InterfaceDataCollector##"
- Hover over "Send to"
- Select "Desktop Create shortcut)"
- Rename the short cut by removing the "Shortcut to"

13) Right click the desktop and arrange icons by type.

14) Check your work
- Double click on "VBS2 LVC Game" Short Cut - Wait awhile
- Click on networking
- Click on new
- Click on Sahrani
- Click on InterfaceTrainerPilot
- Click on OK
- Click on Marine (bottom left)
- Click on OK
- Wait
- Click continue
- After the scenario loads press "ALT & Tab"
- Double click InterfaceDataCollector## Shortcut
- Enter 0001 as your participant number
- Complete the survey and wait for 4-5 seconds
- Your DOS window should then read

"All trigger catalogued"
"All targets catalogued"

15) Control-C
16) Yes and enter
17) Click on VBS2
18) Escape
19) Abort
20) OK
21) Escape
22) Cancel
23) Cancel
24) Cancel
25) Big red X
26) Close windows explorer

APPENDIX E. DLI STUDY INFORMED CONSENT

Informed Consent Form

Introduction. You are invited to participate in a research study entitled "Impact of User Interfaces on Virtual Battlespace 2 Training". This study supports a project to compare different user-input interfaces when conducting military training using VBS2^{TM}.

This study tests procedures to familiarize users with the simulation.

Procedures. The study will consist of the following:
- Survey to better understand the user's level of computer gaming expertise.
- Overview brief describing the research project and VBS2^{TM} simulations basics.
- User training, where participants will be able to move dismount and drive a HUMMV. The participants will also engage targets with personnel weapons and mounted crew served weapons in the VBS2^{TM} simulation.
- User evaluation, where participants will complete a short obstacle course demonstrating their skill level with the simulation.
- Post survey 1.
- 10 minute break.
- User training on a different VBS2^{TM} user-input configuration.
- User evaluation on a different VBS2^{TM} user-input configuration.
- Post survey 2.

The study will take no longer than 2 hours. The first session will last 50 minutes. Then there will be one 10 minute break. The last session will take 50 minutes.

R**isks.** The potential risks of participating in this study are not greater than minimal risk. The only foreseeable risks or discomforts associated with this study is the possibility of participants experiencing simulator sickness, head ache and/or nausea. This possibility is no greater than those encountered when playing civilian video games.

Benefits. The anticipated benefit from this study is gaining insight into how to best configure first person shooter simulations when using them as tactical training devices.

Compensation. No tangible compensation will be given. A copy of the research results will be available at the conclusion of the experiment. If you would like a copy of the results, e-mail Major William Glaser at wrglaser@nps.edu.

Confidentiality & Privacy Act. Any information that is obtained during this study will be kept confidential to the full extent permitted by law. All efforts, within reason, will be made to keep your personal information in your research record confidential but total confidentiality cannot be guaranteed. No information which could identify a participant will be publicly accessible. Records of participation will be maintained by NPS for 3 years, after which they will be destroyed. However, it is possible that the researcher may be required to divulge information obtained in the course of this research to the subject's chain of command or other legal body.

Voluntary Nature of the Study. Participation in this study is strictly voluntary, and if agreement to participation is given, it can be withdrawn at any time without prejudice.

Points of Contact. It is understood that should any questions or comments arise regarding this project, or a research related injury is received, the Principal Investigator, Dr. William J. Becker, 656-3963, wjbecker@nps.edu should be contacted. Any other questions or concerns may be addressed to the Navy Postgraduate School. IRB Chair, Dr. Angela O'Dea, 831-656-2998, alodea@nps.edu.

Statement of Consent. I have read the information provided above. I have been given the opportunity to ask questions and all the questions have been answered to my satisfaction. I have been provided a copy of this form for my records and I agree to participate in this study. I understand that by agreeing to participate in this research and signing this form, I do not waive any of my legal rights.

_____   _____

Participant's Printed Name and Signature   Date

_____   _____

Researcher's Signature   Date

WILLIAM R. GLASER
MAJ, AR (FA57)
NPS MOVES Student

APPENDIX F. DLI STUDY APPROVED IRB PROTOCOL

Naval Postgraduate School
Institutional Review Board (IRB)

From: President, Naval Postgraduate School   **MAR 1 8 2010**
Via: Chairman, Institutional Review Board
To: William Becker, MOVES Institute
William Glaser

Subject: PROJECT STATUS: IMPACT OF USER INTERFACE ON VIRTUAL
BATTLESPACE 2 (VBS2) TRAINING

Encl: (1) Approved IRB Protocol

1. The NPS IRB is pleased to inform you that the NPS President has approved your project (NPS IRB# NPS.2010.0049-IR-EP7-A). The approved IRB Protocol is found in enclosure (1). Completion of the CITI Research Ethics Training has been confirmed.

2. This approval expires on 01 September 10. If additional time is required to complete the research, a continuing review report must be approved by the IRB and NPS President prior to the expiration of approval. At expiration all research (subject recruitment, data collection, analysis of data containing PII) must cease.

3. You are required to report to the IRB any unanticipated problems or serious adverse events to the NPS IRB within 24 hours of the occurrence.

4. Any proposed changes in IRB approved research must be reviewed and approved by the NPS IRB and NPS President prior to implementation except where necessary to eliminate apparent immediate hazards to research participants and subjects.

5. As the Principal Investigator it is your responsibility to ensure that the research and the actions of all project personnel involved in conducting this study will conform with the IRB approved protocol and IRB requirements/policies.

6. After the experiment is completed the Principal Investigator will submit to the Human Subjects Protection Office, all signed informed consent documents, unanticipated problem reports, adverse event reports and a End of Experiment Report. The Human Subjects Research Office will secure these documents for 10 years and then forward to the nears FRC.

Angela O'Dea PhD
Chair
Institutional Review Board

Daniel T. Oliver
President
Naval Postgraduate School

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APPENDIX G. DLI DEMOGRAPHIC SURVEY

1. Please enter your participant number. (Your participant number is the last 4 digits of your home or cell telephone number)
2. Please enter your age.
3. Are you a male or female?
4. Please indicate your military service branch or select civilian.
   a. "Army,"
   b. "Marine Corps,"
   c. "Navy,"
   d. "Air Force,"
   e. "International Military Member,"
   f. "Civilian"
   g. "Retired Military"
5. Please indicate your military rank.
   a. "E1,"
   b. "E2,"
   c. "E3,"
   d. "E4,"
   e. "E5,"
   f. "E6,"
   g. "E7,"
   h. "E8,"
   i. "E9,"
   j. "WO1,"
   k. "CW2,"
   l. "CW3,"
   m. "CW4,"
   n. "CW5,"
   o. "O1,"
   p. "O2,"
   q. "O3,"
   r. "O4,"
   s. "O5,"
   t. "O6
6. Please indicate your what category your MOS falls into.
   a. Operations (Combat arms / war fighter / combat pilot / trigger puller)
   b. Operational support (Military intelligence / linguist)
   c. Logistical support (Supply / transportation / maintenance / admin / legal / dental)
   d. Technical support (Signal / communications / computer specialist)
7. Do you play video games on computers (PC or Mac)?
   a. "Yes,"   b. "No"
8. How many years have you played video games on a personal computer (or Mac) on a regular basis? (Regular basis is defined at least once a week)
   a. _____
9. How many hours per week do you spend playing video games on a personal computer (or Mac)?
   a. _____

- Please turn over and complete survey -

10. When you play video games on a computer what do you play most? (Please Circle)
    a. {"Action (Mario Brothers, Street Fighter)," "First Person Shooter (Doom, Halo, Call of Duty) ,""Sports (EA Sports)," "Action-Adventure (Prince of Persia)," "Adventure (Myst, Resident Evil 4)," "Vehicle Simulation ," "Vehicle Simulation (Racing Games, Flight Sim)," "Role-Playing (Final Fantasy, Everquest, WOW)," "Strategy (War Craft, Command and Conquer)," "Construction and Management (Simcity)," "Life Simulations (The Sims or Second Life)," "Other (Rock Band)"

11. "Do you play console video games at least once a week? (Example of console video games are Sega, PS3, Xbox, Wii, ect)
    a. "Yes,"   b. "No"

12. How many years have you played console video games on a regular basis? (Regular basis is defined at least once a week) (Consoles defined as Sega, PlayStation, Nintendo, or Xbox)
    a. _____

13. How many hours per week do you spend playing console video games? (Console video games are defined as Sega, PlayStation, Nintendo, or Xbox)
    a. _____

14. When you play console video games what console do you prefer?
    a. Playstation   c. Sega
    b. Xbox   d. Nintendo

15. "When you play console video games what do you play most? (Console video games are defined as Sega, PlayStation, Nintendo, or Xbox) (Type (Example))
    a. "Action (Mario Brothers, Street Fighter)," "First Person Shooter (Doom, Halo, Call of Duty) ,""Sports (EA Sports)," "Action-Adventure (Prince of Persia)," "Adventure (Myst, Resident Evil 4)," "Vehicle Simulation ," "Vehicle Simulation (Racing Games, Flight Sim)," "Role-Playing (Final Fantasy, Everquest, WOW)," "Strategy (War Craft, Command and Conquer)," "Construction and Management (Simcity)," "Life Simulations (The Sims or Second Life)," "Other (Rock Band)

16. If you had a choice, would you prefer play a video game on a computer with keyboard and mouse or would you prefer to play the video game on a console gaming system with a game controller. your answer is dependent on the type of game, assume you are playing a first person shooter game such as Doom, Halo, or Call of Duty. I would prefer to play with:

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a. "Keyboard and Mouse,"	b. "Game Controller,"	c. "I have no preference"

17. "Do you consider yourself a gamer?"
    a. "Yes,"   b. "No"

18. Rate your agreement with the following statements by marking an X in one block for each "Computer based simulation can be an effective training tool for unit tactical training."
    a. "Strongly Disagree,"
    b. "Moderately Disagree,"
    c. "Mildly Disagree,"
    d. "No Opinion,"
    e. "Mildly Agree,"

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APPENDIX H. DLI POST EXERCISE SURVEY

1. Please enter your participant number. (Your participant number is the last 4 digits of your home or cell telephone number)
    a. _____

2. Please enter your experimental group?
    a. Group 4 used PS3 and Head Tracker on the first run and PS3 only on second run
,
    b. Group 5 used PS3 and Head Tracker on the first run and Keyboard and Head Tracker on second run.

3. Which user input device did you use on FIRST run?
    a. "Keyboard and mouse,"   b. "PS3 Game Controller"

4. Did you use the Naturalpoint Head Tracker on FIRST run?
    a. Yes, I used the Head   b. No, I did not use the Head
       Tracker   Tracker

5. "This question is in regards to the VBS2 game software only, not the equipment configuration. Rate your agreement with the following statement. VBS2 could provide valuable military training.
    a. "Strongly Disagree,"   e. "Mildly Agree,"
    b. "Moderately Disagree,"   f. "Moderately Agree,"
    c. "Mildly Disagree,"   g. "Strongly Agree"
    d. "No Opinion,"

6. How would you rate your last used VBS2 user input configuration?
    a. "Very Bad,"   e. "OK,"
    b. "Bad,"   f. "Good,"
    c. "Poor,"   g. "Very Good"
    d. "No Opinion,"

7. Do you think your last used VBS2 user input configuration was good enough to conduct valuable military training?
    a. "No,"   b. "Yes"

- Please turn over and complete survey -

8. "Rate your confidence in doing the following tasks in the VBS2 with your last used VBS2 input configuration. (1 means you are HIGHLY confident and 5 means you are NOT confident.)

    a.   Controlling Dismounted movements (walking, running, lying in prone)

1 - Highly Confident	2	3	4	5 - Not Confident

    b.   Observing your immediate environment while dismounted

1 - Highly Confident	2	3	4	5 - Not Confident

    c.   Driving a vehicle (in general).

1 - Highly Confident	2	3	4	5 - Not Confident

    d.   Observing your immediate environment while driving

1 - Highly Confident	2	3	4	5 - Not Confident

    e.   Controlling your M4 rifle to accurately engage targets

1 - Highly Confident	2	3	4	5 - Not Confident

    f.   Finding your targets when dismounted with your M4 Rifle

1 - Highly Confident	2	3	4	5 - Not Confident

    g.   Controlling your M2 heavy machinegun to accurately engage targets.

1 - Highly Confident	2	3	4	5 - Not Confident

    h.   Finding you targets when mounted with your M2 heavy machinegun

1 - Highly Confident	2	3	4	5 - Not Confident

9. Please comment on how to improve the simulation you just used.

APPENDIX I. DLI POST EXERCISE SURVEY ADDITION

1. Please enter your participant number:_____
2. When performing the following tasks in VBS2, which user input device would you prefer?

   a. **Dismounted maneuver - body movements in general (walking, running, lying in prone)**

Keyboard and Mouse	No Preference	PS3

   b. **Situational Awareness while moving dismounted.**

Keyboard and Mouse	No Preference	PS3

   c. **Driving a vehicle (in general).**

Keyboard and Mouse	No Preference	PS3

   d. **Making slow tight turns (avoiding obstacles).**

Keyboard and Mouse	No Preference	PS3

   e. **Making high speed turns (staying on the road).**

Keyboard and Mouse	No Preference	PS3

   f. **Combat parking vehicle (Backing up vehicle).**

Keyboard and Mouse	No Preference	PS3

   g. **Situational Awareness while driving.**

Keyboard and Mouse	No Preference	PS3

   h. **Ability to shoot your rifle (in general).**

Keyboard and Mouse	No Preference	PS3

   i. **Ability to acquire (find) targets with your rifle.**

Keyboard and Mouse	No Preference	PS3

   j. **Ability to accurately engage targets with your rifle (precision).**

Keyboard and Mouse	No Preference	PS3

   k. **Ability to fire your mounted heavy machinegun (in general).**

Keyboard and Mouse	No Preference	PS3

   l. **Ability to acquire (find) targets with your mounted heavy machinegun.**

Keyboard and Mouse	No Preference	PS3

m. **Ability to accurately engage targets with your mounted heavy machinegun (precision).**

Keyboard and Mouse	No Preference	PS3

APPENDIX J. DLI STUDY MAPS

Figure 26.　　Training course map for DLI study

Figure 27.　　Training course imagery for DLI Study
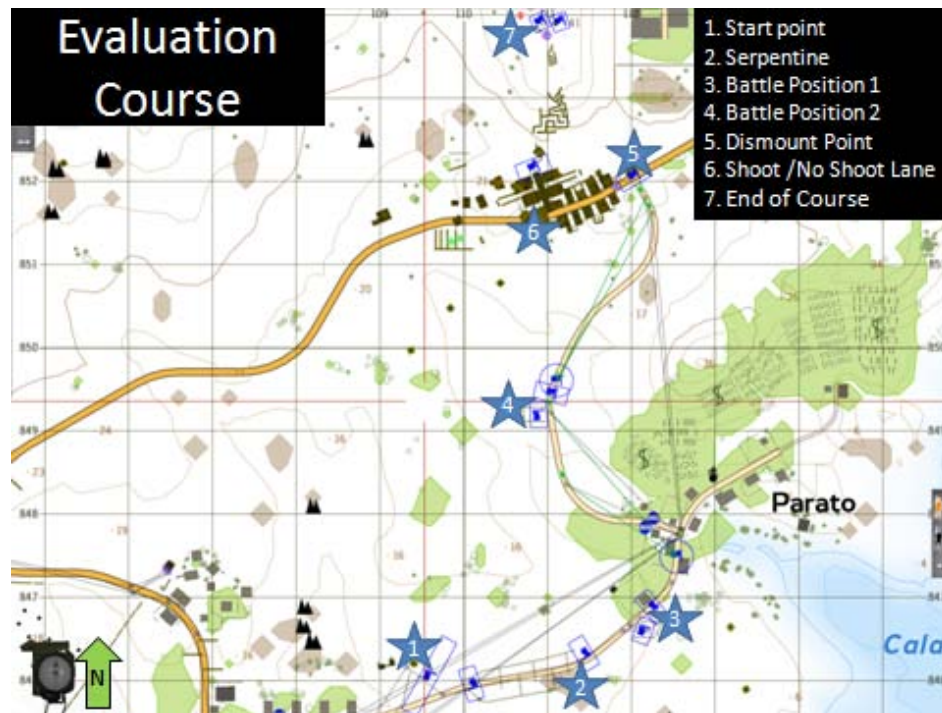
Figure 28.　　Evaluation course map for DLI Study

Figure 29.　　Evaluation course imagery for DLI Study

APPENDIX K. DLI CHEAT SHEETS

Keyboard Hot Key Sheet

Command	PS3 Control
Look	
Look Up	Mouse Forward
Look Down	Mouse Backward
Look Left	Mouse Left
Look Right	Mouse Right
Move	
Forward	W
Backward	S
Strafe Left	A
Strafe Right	D
Drive Slow Forward	Q
Additional Moves	
Run	Left Shift and W
Crouch	X
Prone	Z
Stand Up	C
Weapons	
Fire Weapon	Left Mouse Button
Use Sights	V
Hold Breath	Right Mouse Button
Reload	R
Head Tracker	
Center Tracker	F12
Pause	F9
Other	
Interact With Vehicle	U
Freelook	Left Alt
Compass	Y
GPS	G

PS3 Hot Key Sheet

Command	PS3 Control	
Look		
Look Up	Right Stick Up	
Look Down	Right Stick Down	
Look Left	Right Stick Left	
Look Right	Right Stick Right	
Move		
Move Forward	Left Stick Up	
Move Backward	Left Stick Down	
Move (Strafe) Left	Left Stick Left	
Move (Strafe) Right	Left Stick Right	
Additional Moves		
Run	R2	
Crouch / Up	Push Right Stick Button	
Prone / Stand Up	Push Left Stick Button	
Weapons		
Fire Weapon	R1	
Use Sights	L1	
Hold Breath	L2	
Reload	Triangle	
Other		
Interact With Vehicle	Select	
Freelook	Square	
Compass	Right	
GPS	Left	
Head Tracker		
Center Tracker		F12
Pause		F9

PS3 Hot Key Sheet

L1 / L2

R1 / R2

Select

Start

PS Button

Left Stick

Right Stick

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APPENDIX L.   AAR EVALUATION INSTRUCTIONS

1. Turn On Computer
2. Login

    - Ctrl-Alt-Del x 2
    - User Name: administrator
    - Password: DVTEM90build2
    - OK

3. Move all aar files to be evaluated from AARs for the "AARs for Wesley Review" Folder to c:\documents and settings\Administrator\My documents\ VBS2^{TM} \aar. Note: do not move all in at one time I recommend you move them in blocks of 10 or 12 as not to get aars and participant # confused.
4. Open " VBS2^{TM} Administrator" found on desktop or in a folder on the desktop.
5. click on After Action Review on left side of initial menu screen
6. Click on Sahrani
7. Click on the aar you wish to review. It should show the same files that you moved in the aar folder in step 3.
8. Click on view to hide notepad if necessary.
9. This provides you a view of the map centered on Corazo. Our mission takes place far south of Corazo. Use the scroll wheel to scroll out. Place the cursor over Iguana (in the south) and scroll in. Scroll in on the one blue icon north east of the town between two green vehicle icons. Right click on the blue icon so it flashes. It should say Rifleman - M16A4 - (Marine).
10. Click on View and then 3D Camera View
11. Right click on the green Hummwv and choose lock camera. Right click and drag to change your perspective. Scroll in and out to change your distance from the Hummwv.
12. Click the play arrow to start the aar. Wait, this takes a few seconds. Your camera view should move with the moving vehicle if you properly locked the camera view on the vehicle.
13. Record the Time when
    - The vehicle starts to move, this is usually not zero.
    - Enters the serpentine, (hits the shadow)
    - Count the number to times the Hummwv hits a serpentine wall
    - Exit the serpentine
    - Enters Battle Position 1, (hits the shadow).
    - Hits the first truck (burst into flames), hits the second truck, & hits the third truck
    - Count the number to times the Hummwv hits an object, structure, scenery, street sign, street light, other vehicle, or all four wheels leave the black top road.
    - Enters Battle Position 2

- Hits the first truck (burst into flames), hits the second truck, & hits the third truck
- Count the number to times the Hummwv hits a object, structure, scenery, street sign, street light, other vehicle, or all four wheels leave the black top road.
- End of mounted course / beginning of combat parking lane.
- Score combat parking lane
- End of combat parking lane / beginning of the shoot / no shoot scenario (crossing the green arrows)

14. When the participant dismounts pause the AAR by clicking on the play arrow. Move cursor over the soldier and right click. Choose lock camera. Adjust camera as necessary.

15. The shoot house bad guys targets (green with yellow "X")are Left alley, Right alley, Left Alley, Left Alley. Record how many bad guy targets are hit (should be 4). Record how many good guy targets (Blue) are hit (should be none). A blue tracer means target hit. Record how many total rounds expended.
- Enter Time
- Bad guy targets hit (green)
- Good guy targets hit (blue)
- Total rounds expended
- Exit Time

16. Dismount portion
- Enter time (start ramps - cross green arrow)
- Score ramps. Use the below as a scoring matrix. If the player falls off the ramp add the points below. The lower the score the better. The worst score is a 10. For example, fall off Ramp2a and Ramp3b = 6 pts

Ramp1	Ramp2a	Ramp2b	Ramp3a	Ramp3b	Ramp3c
3	3	2	4	3	2

- End Time Dismount / Start time M4 range (crosses green arrows)

17. Range
- Enter Start time M4 Range (crosses green arrows) - same as above
- Insurgents hits (should be 4)
- Red popup targets (should be 3)
- Total rounds expended
- End time of last target

18. Overall Grade
I need you to assign a subjective overall grade to the run.
- A = user looks as if he could focus 100 percent of his effort on the military training task and 0 percent on using the interface.

Definitely could accomplish the training objectives using assigned user interface in VBS2^{TM}.

- B = user looks as if he could focus 75 percent of his effort on the military training task and 25 percent on using the interface. **Should be able to** accomplish the training objectives using assigned user interface in VBS2^{TM}.
- C = user looks as if he could focus 50 percent of his effort on the military training task and 50 percent on using the interface
- C = 25 percent / 75 percent - ect.
- F = 0 percent / 100 percent - **Definitely could not** accomplish the training objectives using assigned user interface in VBS2^{TM}.

19. Exit

- Click file and chose exit
- Load next AAR or choose Cancel to go to main menu

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